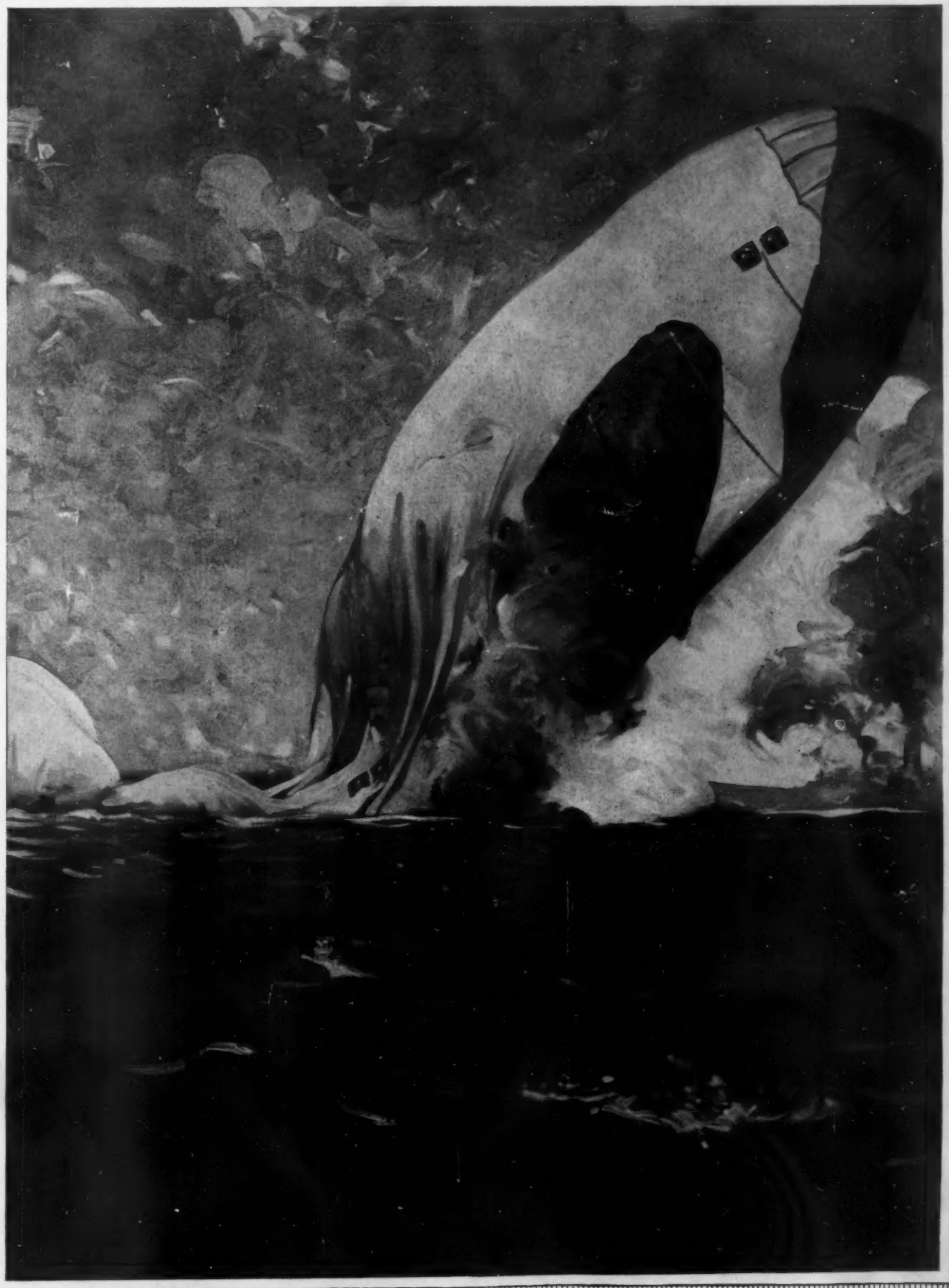
SCIENTIFIC AMERICAN



Vol. CXIII. No. 19
November 6, 1915

Munn & Co., Inc., Publishers
New York, N. Y.

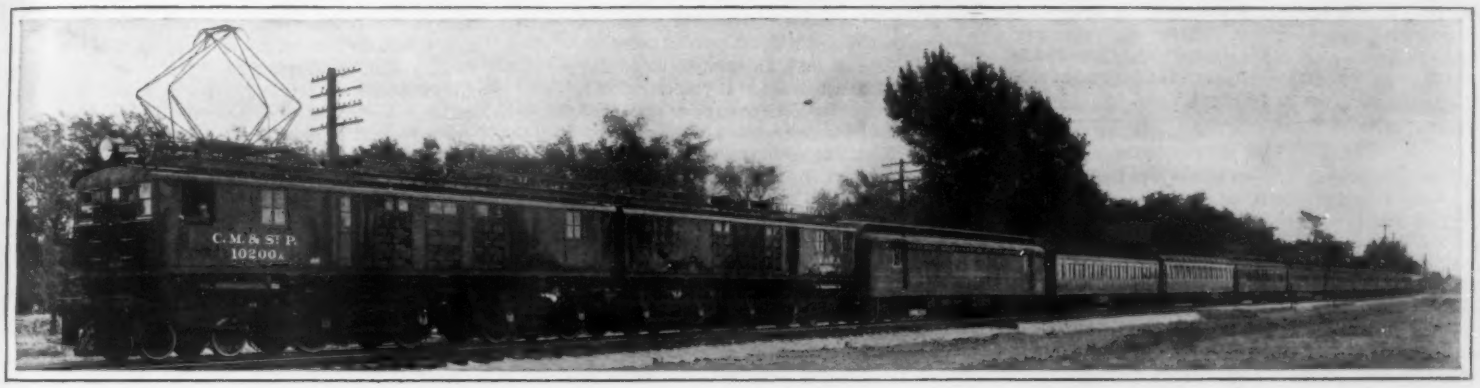
Price 15 Cents
$3.00 A Year

SEVENTY-FIRST YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXIII. NUMBER 19 | NEW YORK, NOVEMBER 6, 1915 | 15 CENTS A COPY $3.00 A YEAR



One of the electric passenger locomotives of the Chicago, Milwaukee & St. Paul Railway, capable of hauling an 800-ton train at 60 miles per hour

Three Thousand-Volt Direct-Current Electric Locomotives

REPRESENTING the last word in the electrification of steam railroad lines, the undertaking of the Chicago, Milwaukee & St. Paul Railway in electrifying 440 miles of its transcontinental system between Harlowton, Montana, and Avery, Idaho, in connection with its through service between Chicago, Milwaukee, St. Paul, Minneapolis and the Pacific north coast, discloses many interesting features. Harlowton is 4,163 feet above sea level, while Avery is at an elevation of 2,494 feet. Two mountain ranges of 6,300 and 5,700 feet, respectively, are crossed by this section of the railroad.

Although the railway placed its initial order for the necessary equipment only in September, 1914, it is announced that the electric locomotives will enter active work some time this month. The overhead construction, which will include 650 miles of single track, has been completed for a distance of more than 200 miles. The 100,000-volt transmission line which is being erected to parallel the electrified tracks has been completed for an equal distance, while the tie-in lines from the 100,000-volt system of the Montana Power Company are ready for service. The trackage now available for train operation includes extensive yards and sidings at Three Forks, Deer Lodge and Piedmont, and passing tracks at other points. The rail bonding crews have followed the overhead construction gangs, completing the ground circuits.

While the electric locomotives are undoubtedly the most interesting feature of the electrification, nevertheless a few facts concerning the trolley construction and transmission lines are worthy of note.

Wooden poles are used throughout the system, both for cross span and bracket construction. The twin No. 0000 trolley wires are suspended individually and separately from the same steel catenary, and the hangers of one trolley wire are located at points mid span on the other. In the switching yards only one trolley wire is used.

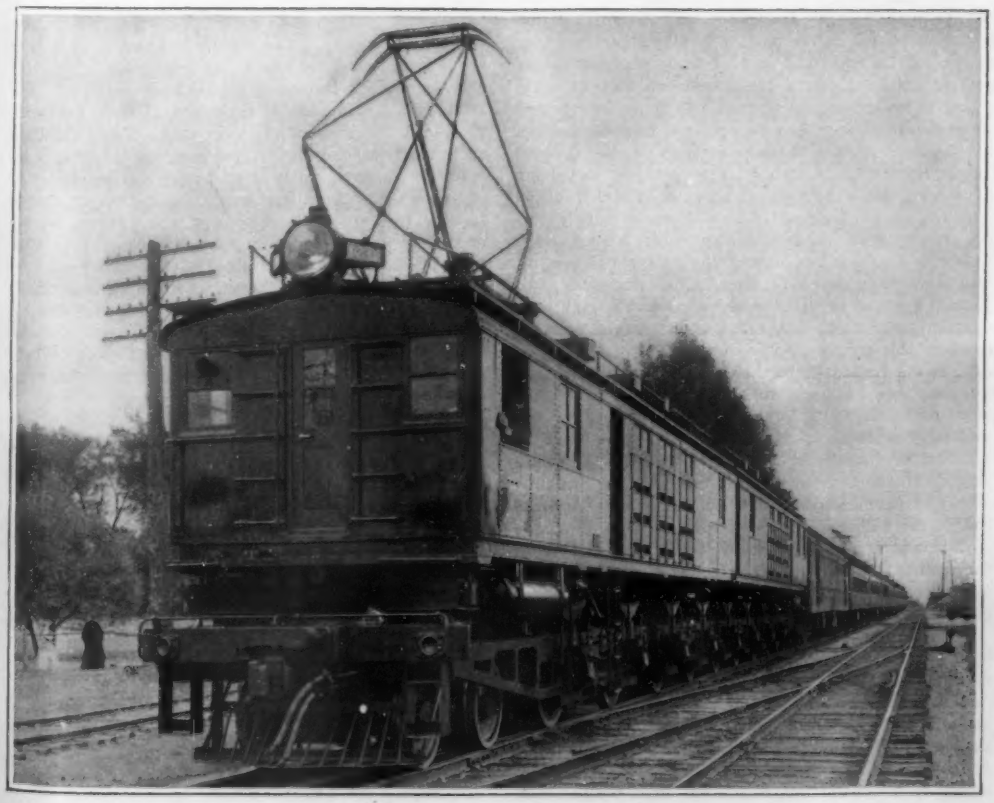
The current for operating the locomotives on the opening stretch of the electrified railroad is derived from Montana water power. This current is sent over the transmission line at a potential of 100,000 volts to the seven substations designed to supply power to the first half of the 440 miles of route. The substations transform the 100,000-volt three-phase alternating current into 3,000-volt direct current through the agency of step-down transformers and rotary converters.

The initial number of electric locomotives for the railroad will be forty-two, of which twelve will be geared for passenger service and thirty for freight. The locomotives are said to be the most powerful ever built and have a continuous capacity greater than that of any steam or electric locomotive in existence. Although each locomotive weighs but 94 per cent as much as a combined Mallet steam engine and tender, which it is replacing, it has a tonnage rating of 23.5 per cent greater and a speed with drag tonnage of approximately 57.5 to 96.8 per cent greater than the latter.

The electric locomotives are each 112 feet 8 inches long, and in reality comprise two distinct machines permanently coupled together and used as a single unit. The capacity of one locomotive is rated at 3,440 horse-power; the entire tractive effort being brought to bear on eight drive wheels, each 52 inches in diameter. In order to save the track from wear and tear by minimizing the vertical and horizontal blows, the drive wheels are fitted with separate motors, individually twin-geared to each of eight pairs of drivers.

Perhaps the most important feature of the new locomotives is that they are the first direct-current engines to operate on a potential as high as 3,000 volts. Furthermore, on down grades the locomotive

(*Concluded on page* 411.)



End view of one of the most powerful electric locomotives ever built. It is designed to operate on 3,000 volts direct current

Section of the single-track electrified railway, showing simple overhead construction, and bonding crews at work

SCIENTIFIC AMERICAN

Founded 1845

Published by Munn & Co., Inc., 233 Broadway, New York, Saturday, November 6, 1915

Charles Allen Munn, President, Frederick C. Beach, Secretary, Orson D. Munn, Treasurer, all at 233 Broadway

Entered at the Post Office of New York, N. Y., as Second Class Matter
Entered as Second Class Matter at the Post Office Department, Canada
Trade Mark Registered in the United States Patent Office

The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

The Freedom of the Seas

IN commercial circles, one of the first lessons that a young business man is obliged to learn is the fact that figures may be made to lie; in politics nothing is more misleading than a scintillating catch word. The "Crown of Thorns" almost brought immortality to our late Secretary of State, but not quite. In the present war nothing has appealed to the sympathy and understanding more than the proposition put forward by Germany for "freedom of the seas." What is really intended by such an appeal; what is the real significance of the term? At first the answer seems readily given; but should the reader ask the question of his friends he would be surprised at the variety of replies it would bring forth. This proposition as put forward by Germany is evidently a protest against the dominance of Great Britain on the high seas. But the questions naturally arise—Has Germany ever been hindered or ever suffered from want of such freedom until the present war began? Has she been the victim of a selfish policy on the part of Great Britain, that has curbed the growth and development of either the Imperial Navy or her mercantile marine; has she suffered from preferential duties or any prohibitory laws which have curbed the growth of her foreign commerce or the development of her marine power? Has England during the last half century exercised her overpowering naval forces against the development of any of her neighbors? On the contrary, has not Germany, as the chief commercial rival of England during this period, developed her maritime marine resources, both naval and mercantile, in a manner which is unprecedented?

Let the facts speak for themselves; and by way of showing the unhindered growth of Germany's deep sea trade, let us look at the record of her principal company, the Hamburg-American. Organized in 1847 this line commenced active operations in 1848 with four sailing ships of 2,441 total tonnage. In 1860 it possessed six sailing ships and five steamers of 14,800 tons; in 1870 eleven steamers of 30,000 tons total; in 1880 twenty ships totalling 55,000 tons; in the next decade the fleet was more than doubled, consisting in 1890 of forty-one ships aggregating 122,883 tons. In the following decade the tonnage was more than trebled, the line possessing in 1900 eighty-three ships totalling 423,931 tons. It had doubled again by 1910, the list showing in this year one hundred and fifty-eight ships of 876,015 tons. At the opening of the war in 1914 the total tonnage had risen to over 1,200,000. In that same year, the North German Lloyd, whose growth during the same period has been also phenomenal, possessed a total tonnage of about 850,000.

Evidently her two great steamship companies have had no cause to complain of interference with the freedom of the seas.

Now as to the general maritime trade of Germany: We find that during the calendar year 1913 there entered German ports 14,262,000 net registered tons of German ships and 12,840,000 tons of foreign ships, and that there cleared from German ports about the same amount of shipping, equally divided between foreign and German, the total entered and cleared being 54,258,000 net registered tons of shipping. The total quantity of goods imported and exported by way of the seas in this year reached the huge total of 78,835,105 tons.

The Editor of the SCIENTIFIC AMERICAN, in view of the above facts, would like to inquire of the German Ambassador, or any German representative who can speak with authority, what is claimed by the German Government in its demand for a greater freedom of the seas? It cannot allude to the practise of blockade, which is recognized as a legitimate weapon of warfare. Does it refer to the interruption of commerce as between neutral nations? If so, it would appear that the Imperial Government has assumed a new rôle of action in defending the rights of neutrals, and in view of the gigantic struggle in which it is engaged it is rather surprising that it should have either the time or inclination to discuss such an abstract proposition, especially in view of its activities in neutral Belgium.

This Government is for freedom of the seas first, last and all the time, and it will be pleased to know whether there has been any period in which the freedom of the seas has not existed within recent times. In case this principle of the freedom of the seas were exercised in the direction of compelling Great Britain to limit or reduce its naval armament to the point at which Germany, with its comparatively limited littoral, would obtain the naval predominance over Great Britain, what guarantee would the world have that the freedom of the seas which had been extended by Great Britain would be continued by the Imperial Government? Furthermore, the question naturally arises, would it be desirable for the peace of the world to have one empire exercise that complete apotheosis of militarism which would include at once an omnipotent military system on land and a complete naval predominance?

We, as Americans, believe in this freedom of the seas, but let us insist upon its being the same freedom of the seas which we and Germany have enjoyed during the past half century.

It is believed that our people would welcome a freedom of the seas which would assure at all times an open pathway for all neutral nations to any nation engaged in hostilities. It is believed that such a condition would be a great advance in the ethics of war, but it would be impossible to bring it about at this juncture in the war; and if it were made a matter of international agreement, what guarantee would there be that in the stress of war such an agreement would be lived up to, especially in view of the way in which treaty rights in the present war have been disregarded?

The Mobilization of American Dye Makers

OUT of a threatened calamity to American manufacturers dependent on dyestuffs has arisen a great and ever-increasing industry during the past twelve months. Problems seemingly impossible of solution have been mastered by an army of patriotic chemists, organizers and capitalists, aided by the support of the Government, in a manner the like of which has never been equalled or even approached in the history of the United States. While the opening days of the European war found the American textile industry dependent almost entirely on European manufacturers of dye materials, the end of the war bids fair to find the United States in a position of absolute industrial independence in this particular at least.

At the outbreak of hostilities, textile and other allied interests in the United States were suddenly brought face to face with a threatened shortage in the supply of dyestuffs from abroad. It may be said that the American manufacturers, accustomed to depending on German sources for their supplies, went home from their plants on one day only to return on the following day to meet the alarming threat of a shortage in their indispensable supplies, as it were, so sudden was the change.

While for some weeks the shipments of dyestuffs from Germany were suspended, as a result of the strenuous efforts on the part of leading representatives of the textile industries and of firms engaged in importing artificial colors the movement was soon restored to nearly normal figures, only to be interrupted seven months later when an embargo was declared on the shipment of dyes of German origin to neutral countries. Since March 15th of this year no shipments have been received, with the single exception of 50 tons coming to the port of New York—a supply sufficient to meet the needs of the nation for a single day! Although England has, during the past seven months, granted free passage to the United States of two steamer-loads of artificial colors of German origin, the German government has refused, on certain grounds, to allow this supply to pass out.

Thus the United States had to shift for itself, since Germany was no longer to be depended upon for dyestuffs and artificial colors. The Government was immediately cognizant of the seriousness of the situation and had an investigation made of the existing conditions, with the discovery of the fact that the available supply of German dyes would be exhausted before the end of the summer. The immediate use of vegetable dyes was promptly urged, as well as the pressing need for economy. And the manufacturers were quick to heed the Government's advice and in every manner possible ameliorate the situation.

The first phase in meeting the dyestuff shortage has been to increase the output of a few existing American establishments devoted to the manufacture of artificial coloring material. Before the war was twelve months old the output of American coal-tar colors had been doubled, great sums of money having been invested in the industry. This, naturally, involved a notable increase in the production of coal-tar dyes, which called into existence a number of new companies engaged in the manufacture of intermediates, especially of aniline. Firms are appearing in great numbers, coming to the rescue of the textile industries. Aid has also been forthcoming by making more extensive use of dyewood extracts.

The question naturally arises: Is all this preparation, initiative and capital in creating the great industry doomed to extinction when German dye makers can again send their goods to our shores? The answer is found in the simple statement made by the Secretary of Commerce through the American press on September 30th, when it was announced that the policy of the present administration would henceforth be to protect American enterprises against foreign rivals. Leaders in the new industry already are looking forward to the moment when the President shall affix his signature to a law making as impossible in foreign trade as it is in domestic trade any attempt to crush, stifle and throttle a new industry. Thus it would appear that the American dyestuff industry, under the protection of the United States Government, is to be a permanent institution, constituting another plank in the platform of our industrial independence which is so rapidly nearing completion.

No more competent person could be found to write on the dyestuff situation than Prof. Thomas H. Norton, Ph.D., Sc.D., of the Bureau of Foreign and Domestic Commerce, who has been in intimate contact with the dyestuff problem ever since it arose. Prof. Norton, in an article the first half of which appears elsewhere in this issue, tells of the past, present and future of the new industry which promises to soon outgrow its babyhood and assume the proportions of a gigantic enterprise.

Awards for New Truth

THERE are a number of institutions that pay people to try to make new scientific discoveries; why is there no institution in our society to pay for the new truth gained by independent scientific investigation? This question has been put to us by C. J. Kullmer, Ph.D., Professor of German at Syracuse University, and in discussing the subject he says that as matters now stand, a man who has spent, say, five hundred hours of labor and five hundred dollars of his own money on a scientific quest which proves successful and yields valuable new truth has no prospect of any direct reward for his labor or of the return of his money. Our society has no adequate system of reward for scientific discovery. In the field of mechanical invention the reward of the investigator is secured by patent protection. Where the new truth takes a form not adapted to sale in the market, society accepts the gift and makes little or no provision for a suitable reward. This is not just and as a system does not stimulate the advancement of knowledge. In institutions of learning increases in rank and salary sometimes, but not always, reward scientific production. Often such increases in rank and salary are made dependent on publication; but this again is not a proper stimulus to scientific work.

What is needed is a direct recompense for all money and for the time and effort expended, given in such a form as to insure public recognition of an attainment valuable to society. The hundred thousand men who are best equipped for advancing knowledge have probably an average income of between one and two thousand dollars. Outside of their special technical work they lead the lives of ordinary men. Their families, their relatives and their friends cannot possibly estimate the value of papers read before learned societies, of articles in technical journals, should they by chance happen to hear of them. Even the various boards of trustees of our five or six hundred colleges have no way of estimating the value of the production of their faculties. Under these circumstances it demands an unusual devotion to science to take from the small family income the money for books, apparatus, assistance, traveling, etc., that is necessary in most investigations, to say nothing of the endless hours of mere drudgery that accompany many a research.

We look primarily and properly to our families, our relatives and our friends for recognition in our life's work. To stimulate scientific production we must reward it in such a manner, we must stamp it in such a way, that the scholar's family, his relatives and his friends may properly value it. Not the international fame of a Nobel Prize, but *an award of national reputation that will mean a local honor.* Such an award should properly come from the national Government, but that seems now difficult of attainment. However, among our men of great wealth there are many sincerely interested in the advancement of knowledge.

A foundation of $10,000,000 would mean one thousand yearly "awards for new truth" of $500 each. A board of directors made up of the leaders in all branches of science would have no great difficulty in reviewing the scientific production of each year and distributing the awards.

Electricity

Electrical Supplies in Cuba.—In Santiago de Cuba and throughout southeastern Cuba there is a constantly increasing demand for electrical supplies and apparatus of various kinds. The American consul for that district announces that all cities of any size are now supplied with electric lights and that electricity is extensively used on plantations.

An Electric Hammer of New Design has recently been evolved by a leading American electrical manufacturer. Briefly, the new hammer consists of a high-speed, series-wound electric motor driving an eccentric mechanism through reduction gearing; the mechanism, in turn, operating a plunger which is virtually the hammer. A sleeve is provided in which the drill or hammer rod may be inserted, so that it can be rapidly struck by the plunger.

New Welding Process for Economizing Platinum.—There has been perfected in England a process for welding platinum contacts on springs, thus effecting a saving in the amount of platinum used. Essentially, the main feature of the process is the placing of a thin coating of copper plate on the platinum, which not only facilitates the task but also reduces the welding current necessary. An automatic welding machine is used in the process. It takes a strip of platinum sheet or a coil of platinum wire, depending on whether a flat or pointed contact is desired, and deposits a piece of platinum of the proper size on the spring and holds it in position during the welding operation. The welded contact is flattened or pointed by a die as it leaves the machine.

New Field Telephone and Buzzer of U. S. Army.—The United States Signal Corps has recently invented a new form of field telephone and buzzer which will hereafter replace the field buzzer, cavalry buzzer and field artillery telephone. The buzzer is strictly a portable instrument for use in the field. It can be employed as a telephone until a break in the line renders this method of communication inoperative; the buzzer method of signaling in the Morse or Continental telegraph codes then being resorted to. When used in the latter manner, the signals are received at the other end of the line in the form of a high pitched hum, broken up to form the dots and dashes of the codes. The line consists of a single wire laid on the ground. The wire is wound on a reel held in a special framework on a soldier's back. The soldier, walking rapidly in the direction in which the line is to be laid, pays out the wire as needed. A simple ground connection is used at both stations for the return circuit. Even with the line severed, it is possible to maintain buzzer communication.

Electricity in Motion Picture Studios.—Although the construction of motion picture plants is rendered very costly by the large areas of glass roofs and walls that are erected to shelter the daylight studios or stages, it is very seldom indeed that the natural light alone can be employed for photographing scenes. Artificial illumination is necessary even on bright days, for sunlight cannot be depended upon—the overshadowing of the sun for even a single moment would spoil a strip of film and necessitate retaking the action. At one time the arc lamp was considered the most suitable form of studio lighting, but to-day it has been almost entirely supplanted by the Cooper-Hewitt mercury vapor lamp. As a rule, it is assumed that for proper lighting there should be a current expenditure of 100 watts in the mercury vapor lamps to each square foot of floor space; stages lighted under these conditions having a floor illumination averaging about 400 foot-candles. However, as in the instance of industrial illumination, no hard and fast rule can be said to govern the lighting requirements of all studios.

An Explanation for Increased Radio Antenna Resistance.—In a paper prepared by L. W. Austin and issued by the Bureau of Standards, an explanation is offered for the increase in resistance in radio antennæ when the wave length is increased. The resistance of an antenna may be subdivided into three parts: the ohmic resistance in the wires comprising the aerial system; the so-called radiating resistance, and the earth resistance. By way of beginning his explanation the author compares an antenna and the earth below it to the two surfaces that form an electrical condenser. Further, he calls attention to the poor conducting medium between the surface of the earth and the actual conducting medium some distance below. The poor conducting material acts as an imperfect dielectric, and in the testing of imperfect condensers it is an established fact that the dielectric losses increase in direct proportion to the wave length of the current employed in the measurements. This, the author claims, is the reason for the increased antenna resistance with increase of wave length, and in the way of proving his theory he has placed on the surface of the ground below an antenna large surfaces of wire netting, which resulted in a lowering of the antenna's resistance.

Science

The British Association, notwithstanding the war, had a most successful meeting this year, at Manchester, with 1,438 members in attendance. Social features were almost eliminated, apart from a reception by the Lord Mayor, held at the School of Technology. Next year's meeting will be held at Newcastle, under the presidency of Sir Arthur Evans, and the following year the association will meet at Bournemouth.

Philippine Botany.—The present status of knowledge regarding the flora of the Philippines is reviewed in a recent paper by E. D. Merrill, in the *Philippine Journal of Science*. In the past 15 years the number of known species of flowering plants has increased from 2,500 to more than 7,000, but it is probable that the total number is not less than 10,000. Most definite botanical exploration has thus far been confined to parts of Luzon and Mindanao.

A New Survey Vessel for Alaskan Waters.—The U. S. Coast and Geodetic Survey has just awarded a contract for the construction of a 1,000-ton steamer, to be used in surveying the dangerous waters of Alaska and Bering Sea. The vessel, which is to be named the "Surveyor," will accommodate a crew of 66 officers and men and will cost, with her equipment, $220,000. Strange to say, the construction of this vessel, destined for service in Alaska, has been undertaken by a firm at Manitowoc, Wis., on Lake Michigan.

The Memorial Volume of the Transcontinental Excursion of 1912 has been published by the American Geographical Society. Sad, indeed, is the contrast between the spirit of international fellowship that brought together on that memorable journey the leading geographers of Europe and the senseless struggle that now separates them. The volume contains 26 papers by the members of the expedition, in English, French, German and Italian, and presents a unique series of impressions of American geographic features from the European point of view.

Recent Explorations in Brazil.—In a recent letter to Mr. Roosevelt, Col. Rondon, the Brazilian army officer who took part in the famous expedition that explored the "River of Doubt" (Rio Theodoro), reports the completion of the overland telegraph line with the construction of which he has been busy for several years, and which was brought to public notice in connection with the expedition above mentioned. This remarkable line, having a total length of 972 miles, extends from Cuyabá to Santo Antonio, on the Madeira, and thus intersects a vast and little-known jungle. A road has been built along the route of the telegraph, and the pacification of the Indian tribes has been a feature of the undertaking. Col. Rondon is now preparing an official report of his explorations and maps of the region traversed. He states that Lieut. Marques de Souza was sent last February to descend the Ananáz River, which is supposed to be the source of the upper Aripuana, the latter being one of the chief affluents of the Theodoro.

Wire Drag Surveys Off the Massachusetts Coast.—The old method of hydrographic surveying with the lead line is adequate for showing the slopes of the bottom, but does not reveal the presence of all isolated rocks and ledges, such as abound on some coasts and are a serious menace to navigation. In recent years the U. S. Coast and Geodetic Survey has made successful use of an appliance known as the "wire drag"; viz., a wire several thousand feet in length, supported at any desired depth in the water by specially designed buoys, and towed by two or three power boats. If no obstruction is encountered, it is known that no dangers to navigation exist above the depth to which the apparatus is adjusted. The Survey announces that during the past season a survey, by this method, has been made of the approaches to the port of Boston and along the coast as far as Plymouth, including the route between Boston and the Cape Cod Canal, and numerous patches of pinnacle rocks and boulders have been discovered. All dangers, however small in extent, will hereafter be shown on the charts of these waters.

Thunderstorms in the United States.—In the *Monthly Weather Review* Mr. W. H. Alexander has published a series of 13 charts, showing, for each month and for the year, the frequency of thunderstorms occurring at the regular stations of the Weather Bureau during the 10-year period 1904-1913, inclusive. Taking the year as a whole, we find two regions of maximum frequency; one over Florida and the other over northern New Mexico. The station having the highest record is Tampa, Fla., with 944 thunderstorms in 10 years, or nearly a hundred a year. Two other Florida stations had more than 800. In the New Mexico centre of high thunderstorm frequency Santa Fé is credited with 732 thunderstorms in 10 years. The fewest storms are recorded at stations on the Pacific coast, especially in California and Washington, the record for infrequent thunderstorms being held by San Francisco, with only 8 in 10 years.

Astronomy

Classification of Visibility in the Telescope—A recent publication of the British Astronomical Association gives a convenient classification of the different ways in which objects are seen in the telescope, as follows: A *glimpse* of an object does not last more than 0.3 second. A *short view* lasts from 0.3 to 1 second. An object *held steadily* is one whose visibility continues for 1 second and above.

The Number of Stars visible in the largest telescopes has been variously stated. A few years ago an estimate of 125,000,000 was current. According to a recent estimate by Chapman and Melotte there are about 219,000,000 stars brighter than the twentieth magnitude. Prof. Hale has recently stated that "there is reason to hope that a 100-inch telescope would add nearly 100,000,000 still fainter stars, many of them lying beyond the boundary of the universe as at present known," and within a year or so such a telescope (*i. e.*, a reflector) will probably be in use at Mount Wilson Observatory.

Temporary Stars.—Most of the textbooks suggest that temporary stars, or "novæ," may result either from the collision of two bodies in space or from a sudden explosion or eruption of a single body. Prof. Hale, in his recent review of the last ten years' work at Mount Wilson, states that a more plausible hypothesis is that of a faint star suddenly plunging into a gaseous nebula. The spectra of novæ, after passing through remarkable changes, have usually been supposed to correspond closely in their last visible stage with the spectra of nebulæ. Observations at Mount Wilson, however, are in harmony with an observation of Hartmann in showing that there is, at least in some cases, a still later stage, in which the characteristic lines of the nebular spectrum disappear, as if the star had finally passed out of the nebula which caused its sudden outburst of luminosity. On this hypothesis, the temporary brightness of these stars would be analogous to that of a meteorite passing through the earth's atmosphere and raised to incandescence by friction.

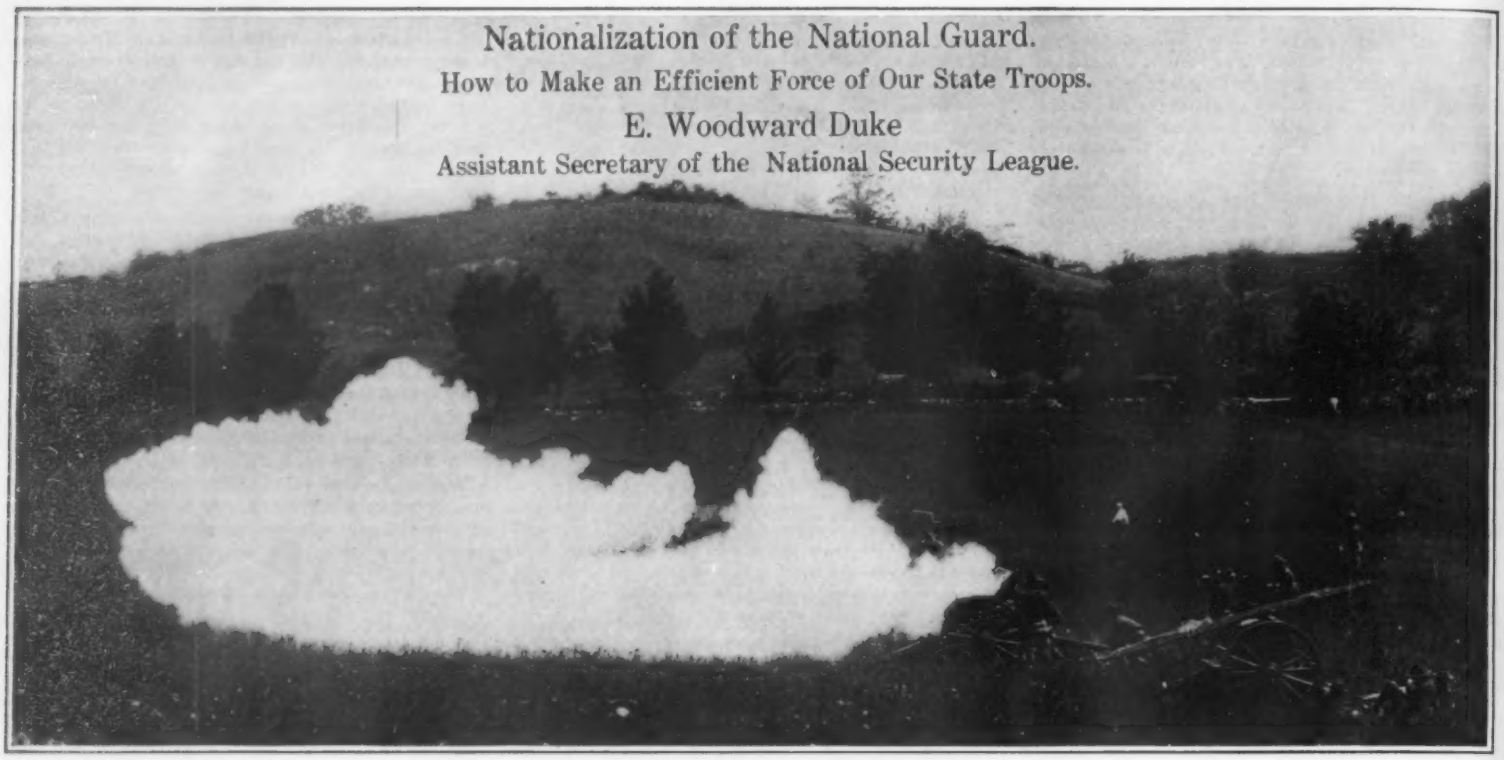
The Canals of Mars.—According to the report on the 1909 opposition of Mars, just published by the "section for the observation of Mars" of the British Astronomical Association, under the direction of E. M. Antoniadi, "the alleged existence of a geometrical network of canals on Mars has received a lasting and unanswerable confutation." Mr. Antoniadi had the advantage of using on Mars the great Meudon refractor, the most powerful telescope in the Old World. In working with smaller instruments he himself had, like other observers, obtained frequent glimpses of narrow, straight lines, but in the Meudon instrument these lines were seen only when the definition was bad and the image of the planet "flaring." With good seeing, a complex natural structure of the so-called "continental" regions of the planet was revealed, a variety of irregular bands and shadings, replacing the sharp, narrow lines drawn by Schiaparelli, Lowell and others. Mr. Antoniadi pronounces the geometrical lines, and also the doubling of the lines, mere optical illusions, and presents a large number of his own drawings side by side with those made of the same regions by Schiaparelli and Lowell, in support of this contention. He notes that the markings which Schiaparelli only glimpsed with his modest 8½-inch refractor were held quite steadily in the 32¾-inch refractor at Meudon.

A Calendar for Mars.—In discussing periodic phenomena observed on the surface of Mars it is desirable to have some way of recording their time of occurrence with respect to the Martian year and seasons. A Martian calendar proposed a few years ago by Prof. Douglass, of the Lowell Observatory, divided the planet's year into 365 parts, corresponding to 365 equal angular divisions of its orbit, but to unequal periods of time, owing to the eccentricity of the orbit. A somewhat different calendar is described by Prof. W. H. Pickering in his 10th Report on Mars. A Martian year is about 687 terrestrial days in length, but contains only 668.6 Martian solar days, as Mars has a slightly longer period of rotation than the earth. In order to avoid the complication of leap years, Prof. Pickering ignores the solar day, by which an inhabitant of Mars would presumably regulate his daily life and set his clocks. For the purposes of the calendar the planet's year is divided into exactly 669 parts, or calendar days, the length of one of which is about 53 seconds less than that of the Martian solar day. These calendar days begin all over the planet at the same time. The year is divided into 12 months, named to correspond with our own. The first nine months contain 56 Martian days, and the last three 55. The date depends upon the longitude of the sun as seen from Mars. Thus it is August 55 in Mars when the sun's longitude is 159 deg. The terrestrial date corresponding to the same solar longitude is September 1st.

Nationalization of the National Guard.

How to Make an Efficient Force of Our State Troops.

E. Woodward Duke
Assistant Secretary of the National Security League.



A battery of national guard field guns in action

IN its effort to secure from Congress the legislation necessary to provide adequate preparedness for National Defense, the National Security League and its several committees have investigated and reported upon various facts and measures showing the situation and needs of the country.

It is unfortunately not generally understood that preparedness is not measured in terms of men alone, but relates to all the various mechanical devices and appliances available for war. This in itself is an enormous and costly element; but equally important and essential is the organized human force necessary to utilize the many mechanical appliances required for waging a modern war. The handling of guns, ordnance of all kinds, ships for over and under sea use, aeroplanes, electrical devices, explosives, calls for men properly educated, trained and organized for the purpose.

A democracy such as ours, is, in the main, dependent upon the Militia in time of war. The Militia under our Constitution consists of all able bodied males between the ages of 18 and 45 years, but this great body of men consisting of approximately 25,000,000 people, has received no training to fit them for rendering the duty required by their citizenship, and we have moved along in sublime indifference and blissful ignorance until the awakening which the present war in Europe has brought about.

Without question, the most difficult phase of the problem of obtaining an adequate National Defense that now confronts the American people and Congress is: How economically and effectively to convert that portion of our twenty-five million potential national defenders into the "citizenry trained and accustomed to bear arms" sufficient for purposes of defense.

At no time during our 139 years of existence as a nation, has a comprehensive or effective effort been made to train and organize our militia into the properly

A national guard armored automobile

balanced and equipped body necessary for waging a successful war. Half-baked makeshift laws have from time to time been passed by Congress and the various states, with results in each case almost wholly farcical.

Every student of history knows that in every war we have fought, it has been necessary to equip, organize and train our army after war had begun. This policy, so wasteful of men and material, is so thoroughly inconsistent with shrewd American business methods that one marvels at the assininity of a nation that will persist in it.

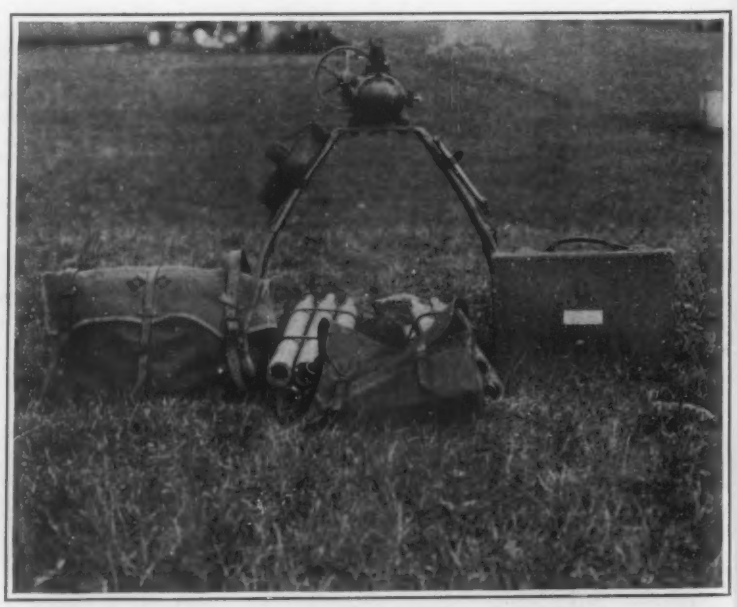
Our present National Guard is by far the most effective organization of citizen soldiers that we have ever had, and the officers and men composing it deserve great credit for what they have accomplished; yet it comprises but about one half of one per cent of our potential resources of men available for purposes of defense, and is as a whole so far below the standards of modern war in equipment, organization and training that it is thought by many, who have devoted years of careful study to this problem, that it would be wise to entirely abandon our present system.

I do not feel disposed to approve such drastic action and would hesitate to do so if I did, for it is the policy of the National Security League to leave the solution of such technical problems to the men whose position, education and training along military lines best fit them to decide such matters.

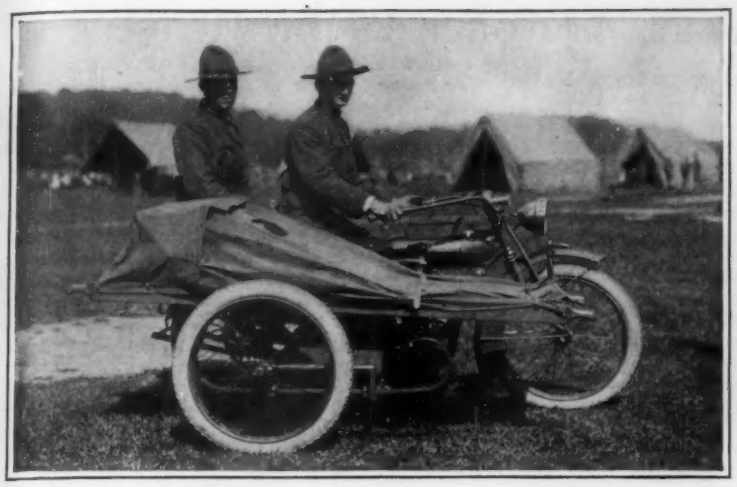
Having served a number of years as a Captain and Company Commander of the National Guard, I have taken a special interest in that part of the League's work relating to the Guard.

In order to learn how the League might most effectively serve the best interest of the National Guard, I wrote to many officers in various parts of the country requesting their opinions and suggestions. Without exception, they all agreed that the first and most important step necessary was to place almost the entire

Telephoning the range to a battery of artillery



Wireless equipment packed for transportation on a mule



Motor-cycle fitted with an ambulance side-car

Baking bread for the army in the field kitchen

control of the Guard in the hands of the War Department;—in a word, to nationalize the organized Militia, making the Guard a National Guard, in fact, as well as name. The following from Gen. Albert J. Logan, of Pittsburg, Pa., is practically a summary of replies received to my requests.

"In regard to the best support that might be given to the National Guard, it occurs to me that it can be summed up in better financial support from the Federal Government and earnest moral support of all good citizens. In many of the states, and more pointedly in others, the Guard is expected to maintain an efficient organization without sufficient financial aid, therefore, I believe that the first important step is to have the allowance made for the support of the National Guard increased and proper armory facilities provided. The Militia Pay Bill that has been asked from the Federal Government is of vital importance in building up and maintaining an efficient organization. The moral support from good citizens is also a very important factor in maintaining an effective organization. I think that the results accomplished through the efforts of the League in securing for the National Guard the endorsement of large employers of men is very good and desirable, but, I do not think that the support of the large employers of men alone should be encouraged, and the fact that some of them offered to allow their men, who are members of the National Guard, such time as is necessary for instruction to be absent from their employment without loss of pay, should not be made too much of a feature. If the National Guard was composed of young men employed by the larger and wealthier employers, it would have a tendency to have the organization looked upon as a corporation organization. We should rather encourage all good citizens to feel that they have a part and a duty to perform in the protection of their nation. I believe that if we will dwell on the idea that service in the organized Militia or National Guard is an honorable one and a patriotic duty, it would encourage young men to associate themselves with the service, because of the fact that they will be helping their Government, and that this service is as much a part of our National Government as any other department or division thereof, and not as now in many cases having these young men criticised and twitted for belonging to the service. If employers of men would endeavor to adapt their work so that members of the Guard might be able to attend the necessary duties as required by the National Guard service, giving them their moral support and encouragement, I believe that is all that should be required and all that would be necessary. I do not see why any particular class of employers of men should be called upon to compensate men for the time they would serve in the Guard; but if they will make it possible for them to have the time away from their employment (which should not be a great number of days in any one year) that would be doing what is fair, and with these conditions prevailing, a large number of men could be trained to be efficient in the military service at a much less cost than any other system I can think of."

Detachment of the Seventh Regiment, N. Y. N. G.

A battery of machine guns in action

Of the many conditions that mitigate against the National Guard fulfilling its function, the two that stand out most conspicuously are lack of men and lack of funds.

As a nation we are prone to have nothing but praise for the volunteer in time of war and disinterest if not scorn for the same man in time of peace. Unquestionably, the young man who in time of peace acquires the training that will fit him for efficient service in time of need deserves a great deal more credit than the one that persistently refuses to secure that training, but with his patriotism afire burdens his country with the necessity of training him after hostilities have begun.

It is unfortunate that there should exist in this country so large a class of citizens who openly sneer at the Guard. To question their own patriotism is to offer them insult, yet they persistently maintain an attitude that is not only distinctly unpatriotic, but creates a condition that is one of the greatest obstacles preventing the establishment of an ade-

(*Concluded on page* 410)

Building a pontoon bridge across a creek

Fording the creek after the bridge was destroyed

Strategic Moves of the War, October 27th, 1915

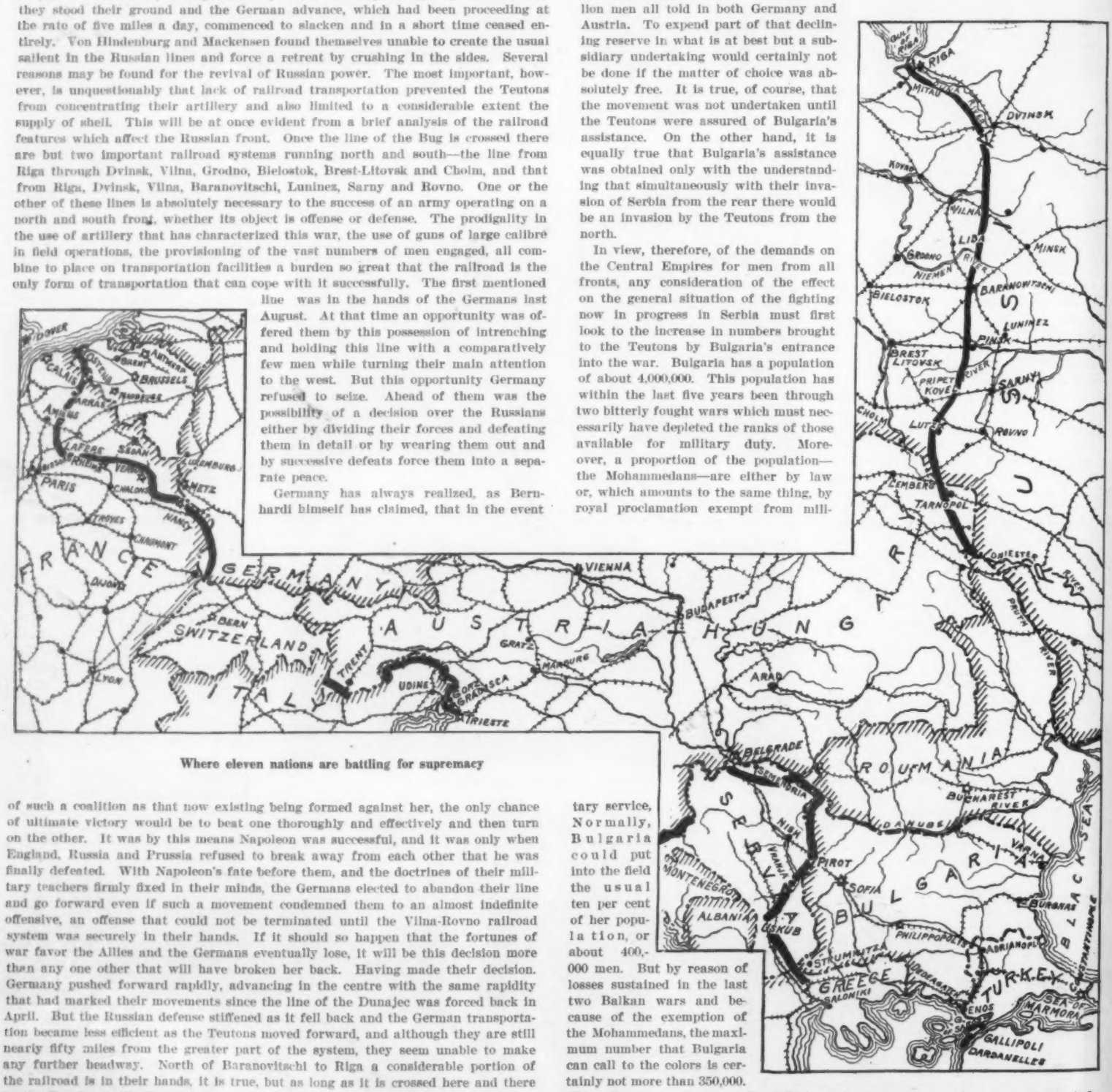
By Lieut. J. B. W. Gardiner, Formerly of the 11th Cavalry, U. S. A.

WHILE not as dramatic as the operations against Serbia which have for the past several weeks occupied the greater part of the attention of both the public and the press, the situation in Russia is, from a strictly military point of view, much more interesting and certainly vastly more important. The Russians, driven from the Dunajec to the San, from the San to the Vistula and the Bug, and from there to the Dvina, the Niemin, the Styr and the Sereth, seemed entirely outclassed as a fighting machine and were apparently doomed to retreat until the marshes east of Pinsk forced a division of their forces. Then by concentrating on the various units, first one and then another could be defeated and a decision reached. For months there was no relief—the result seemed to be the inevitable total defeat of Russian arms. At Warsaw, at Ivangorod, at Vilna, at Riga, they were apparently trapped, and in each case barely managed to escape before the trap was sprung. But suddenly they stood their ground and the German advance, which had been proceeding at the rate of five miles a day, commenced to slacken and in a short time ceased entirely. Von Hindenburg and Mackensen found themselves unable to create the usual salient in the Russian lines and force a retreat by crushing in the sides. Several reasons may be found for the revival of Russian power. The most important, however, is unquestionably that lack of railroad transportation prevented the Teutons from concentrating their artillery and also limited to a considerable extent the supply of shell. This will be at once evident from a brief analysis of the railroad features which affect the Russian front. Once the line of the Bug is crossed there are but two important railroad systems running north and south—the line from Riga through Dvinsk, Vilna, Grodno, Bielostok, Brest-Litovsk and Cholm, and that from Riga, Dvinsk, Vilna, Baranovitschi, Luninez, Sarny and Rovno. One or the other of these lines is absolutely necessary to the success of an army operating on a north and south front, whether its object is offense or defense. The prodigality in the use of artillery that has characterized this war, the use of guns of large calibre in field operations, the provisioning of the vast numbers of men engaged, all combine to place on transportation facilities a burden so great that the railroad is the only form of transportation that can cope with it successfully. The first mentioned line was in the hands of the Germans last August. At that time an opportunity was offered them by this possession of intrenching and holding this line with a comparatively few men while turning their main attention to the west. But this opportunity Germany refused to seize. Ahead of them was the possibility of a decision over the Russians either by dividing their forces and defeating them in detail or by wearing them out and by successive defeats force them into a separate peace.

Germany has always realized, as Bernhardi himself has claimed, that in the event of such a coalition as that now existing being formed against her, the only chance of ultimate victory would be to beat one thoroughly and effectively and then turn on the other. It was by this means Napoleon was successful, and it was only when England, Russia and Prussia refused to break away from each other that he was finally defeated. With Napoleon's fate before them, and the doctrines of their military teachers firmly fixed in their minds, the Germans elected to abandon their line and go forward even if such a movement condemned them to an almost indefinite offensive, an offense that could not be terminated until the Vilna-Rovno railroad system was securely in their hands. If it should so happen that the fortunes of war favor the Allies and the Germans eventually lose, it will be this decision more than any one other that will have broken her back. Having made their decision. Germany pushed forward rapidly, advancing in the centre with the same rapidity that had marked their movements since the line of the Dunajec was forced back in April. But the Russian defense stiffened as it fell back and the German transportation became less efficient as the Teutons moved forward, and although they are still nearly fifty miles from the greater part of the system, they seem unable to make any further headway. North of Baranovitschi to Riga a considerable portion of the railroad is in their hands, it is true, but as long as it is crossed here and there by the Russian battle line it is impossible to use even those sections of it that they hold. There are a number of lines running up perpendicular to the German front from the west—the roads from Grodno to Vilna, from Billostok to Ledo and Baranovitschi, from Brest-Litovsk to Luninez and to Lietsk. But there is no line parallel to the front over which supplies can be distributed. Germany therefore, at a time when the greatest demands are being put on her, finds her army in the east in a very uncomfortable position—between two lines, one of which is too far in her rear to be of value and the other on her front held by an enemy she can no longer drive. Here then was the situation before the offense against Serbia was begun. On the west, in France, Germany could not go ahead nor could she prevent the steady push eastward of the French trenches; on the east, in Russia, she had found herself confronting a defense that was somewhat stronger than her offense; on the south, in Galicia, the Russians were steadily advancing and capturing large numbers of prisoners as they moved forward. The Balkans were seething; action by one or all of the Balkan states was possible, and something had to be done that would exert the proper effect at the proper moment. The Dvinsk movement was proving unsuccessful, and south of the Pripet marshes to the frontier of Rumania the Russians were not only holding their own but were steadily pushing the Teutons back with grave losses in killed, wounded and prisoners. If the Balkan states were to be properly influenced some spectacular move would have to be made, a move that was certain of success and which was close enough to them to absolutely fix their attention. And this was in great part, at least, the origin of the attack on Serbia. We cannot but doubt that Germany would have elected to make such a move for military reasons at a time when the drain on her reserve in men was so great and when on both eastern and western fronts there was the strongest demand for reinforcements. The reserve remaining to the Teutons is none too great in any event, certainly not more than two million men all told in both Germany and Austria. To expend part of that declining reserve in what is at best but a subsidiary undertaking would certainly not be done if the matter of choice was absolutely free. It is true, of course, that the movement was not undertaken until the Teutons were assured of Bulgaria's assistance. On the other hand, it is equally true that Bulgaria's assistance was obtained only with the understanding that simultaneously with their invasion of Serbia from the rear there would be an invasion by the Teutons from the north.

In view, therefore, of the demands on the Central Empires for men from all fronts, any consideration of the effect on the general situation of the fighting now in progress in Serbia must first look to the increase in numbers brought to the Teutons by Bulgaria's entrance into the war. Bulgaria has a population of about 4,000,000. This population has within the last five years been through two bitterly fought wars which must necessarily have depleted the ranks of those available for military duty. Moreover, a proportion of the population—the Mohammedans—are either by law or, which amounts to the same thing, by royal proclamation exempt from military service. Normally, Bulgaria could put into the field the usual ten per cent of her population, or about 400,000 men. But by reason of losses sustained in the last two Balkan wars and because of the exemption of the Mohammedans, the maximum number that Bulgaria can call to the colors is certainly not more than 350,000. This, however, is a well drilled veteran army, and were our minds not accustomed to the idea of the millions already engaged on the French and Russian fronts, would be considered a formidable force. If Bulgaria had only the Serbians to consider and did not have to use part of her forces for other purposes, there would be, adding the 200,000 Teutons under Mackensen, about 550,000 men available for the Serbian operations. But Bulgaria has other things to think of. Rumania on her northern frontier threatens to side with the Entente and the littoral along the Black and the Aegean seas is under constant bombardment from their battleships. A large part of the Bulgarian army cannot, therefore, participate in the offensive operations against Serbia, so that Serbia has opposed to her probably not more than 400,000 men. On the north the weakness of the Teutons in numbers is daily becoming more manifest. In spite of the fact that Serbia, decimated as her forces have been by war and by pestilence, cannot oppose the 400,000 Teutons and Bulgars with more than 250,000 men, the progress down

(Continued on page 413)



Where eleven nations are battling for supremacy

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Some Suggestions Regarding Patent Office Practice

To the Editor of the SCIENTIFIC AMERICAN:

It is my understanding that the rules of practice of the Patent Office are at the present time being subjected to careful revision by a special committee selected for this purpose by the Commissioner of Patents, said committee acting under his supervision.

It has occurred to me that, if from time to time your publication could be used by patent practitioners to present their views by way of objections and suggestions in relation to the present rules, much benefit would be derived by the profession and those who now or in the future may be in control of the revision work.

I have in my files a letter from the present Patent Commissioner, Mr. Ewing, suggesting in relation to the publication in the SCIENTIFIC AMERICAN of an address before the Chicago Bar Association that your medium was used in order that his views would "reach the profession more generally than through any other publication." It is with the above in mind, therefore, that I have taken the liberty of now sending you a résumé of certain observations regarding the patent practice under the present rules, observations based upon some 16 years' active experience in practicing before the Patent Office.

PRESENT RULE 75

I have for a number of years viewed the practice incident to the operation of this rule as not altogether fair either to the public or to patentees whose patents may happen to be overlapped by subsequent patents based upon later applications. It is well known that during the early operation of Rule 75 an applicant was permitted to "swear back" of an unexpired domestic patent and receive a claim or claims dominating such patent, by submitting a showing of completion of his invention prior to the patentee's filing date, which showing was certainly most inadequate and unconvincing. It is true that in later years the practice has become more rigid or stringent in this connection and it may possibly be that the showing now required is in the nature of fairly good evidence. Notwithstanding this, however, I still believe that the patentee whose invention is "sworn back of," so to speak, does not get really fair play. To those versed in the practice, the omission by such patentee of claims of the breadth of those contended for by the subsequent applicant, is not the fault of the patentee strictly speaking, but rather due to the incompetency of his attorney or possibly other conditions for which the earlier patentee is not responsible. In respect to many patents which I have had occasion to consider and which include claims anticipated by unexpired patents but secured through the provisions of Rule 75, I have been led to the conclusion that, had the earlier patentee been given an opportunity to contest the grant of a dominating patent on the subsequent application, facts would have been adduced preventing such grant. But I am free to say that, irrespective of the merits of such a case as between the parties directly concerned, I regard the interest of the public of greater importance and feel that in some way or other Rule 75 might be modified to make more certain the equity of the grant of the monopoly to the party who supplies the showing required by said rule, a monopoly which on the face of the records is the result of a wholly *ex parte* proceeding. I dislike to criticize without being able to offer a better remedy than the suggestion of giving due notice affording the opportunity to contest on the part of the patentee. However, my present limited consideration of the subject fails to afford me a knowledge of a better remedy though I submit that one may and will ultimately be devised.

MULTIPLICITY OF CLAIMS

While doubtless in respect to far more than the majority of classes of inventions the question of multiplying claims in patents is not of great moment, to those practitioners working in the arts of more complicated machines this question and a remedy for the condition is an ever present one. To my mind, however, the manner in which the Patent Office itself is affected by the introduction in applications of claims ranging into hundreds in number is the serious aspect of the situation.

I had occasion some time ago to prepare the claims for a British application to cover the subject matter of a pending United States application for a very complicated registering machine. I was struck at the time with the comparison involving the fact that in the United States application there were originally over 160 claims. Owing to the British practice I was compelled to condense the subject matter of that large number of claims into approximately 25 British claims, which are each required to characterize a different idea or constructional feature from anything presented in a preceding claim or claims, as every one knows who is familiar with British practice.

After a fairly considerable experience in handling intricate cases of the above class I am concluded in my opinion as an attorney that we attorneys at the present time are permitted to insert a larger number of claims in our cases than ought to be inserted, or rather a larger number than the examiners should have the burden of examining. The proposition of building up claims step by step, one upon the other, when the real elemental difference between a claim and preceding ones is not very great, should be prevented by some equitable rule. Of course so long as attorneys are paid for their work and their competitors are permitted on behalf of clients to draft claims running into hundreds in number, an attorney feels it incumbent upon him to present the large number of claims as the usual thing. It is possible in respect to practically all complicated inventions submitted to the Patent Office, not including divisional features, to embody within the limit of 50 claims the important subject matter of the invention represented by each claim. I state the above limit with hesitancy knowing there may be considerable variance of opinion in reference thereto. However this may be, is it out of reason for the commissioner to set a limit? When the claims run into a very large number in Great Britain the applicant is politely informed that they are multitudinous and that the invention must be set forth with sufficient definiteness. In Germany I doubt very much that the Patent Office would examine an application containing 50 claims, or possibly a number much less.

I believe in setting a limit for the examiners are overworked now and an examiner who has to get his work up to date is only human and cannot do justice to cases acted on where the claims run from 50 to 200 in number. The possibility of invalid claims being found amongst such a large number of claims is great. The attorneys will fit into a practice where limitation is placed in this connection and though they may be horror-stricken at first they will cooperate subsequently just as they did after Commissioner Ewing set the limit of pendency of an application.

ORAL PRESENTATION OF COMPLICATED INVENTIONS

This suggestion also relates to applications covering complicated machines or the like. If it were allowable for the examiner to notify counsel that on such a day he would examine an application and request the attorney to be present to answer questions and present the invention generally, much time would be saved to the examiner in arriving at a real understanding of the invention and the points of novelty which are deemed to exist. The object in view is to furnish as quickly as possible an explanation of the essentials of structure and operation. I have myself spent as much as two days and longer in reading over a specification and drawings of a complicated patent seeking to get an intelligent comprehension of the invention in so far as the elemental operation of the same is concerned. Often in such a case a 20-minute explanation would have saved a day's work.

FORMALITIES

In conclusion I might state that I am of the opinion that where specifications are somewhat lengthy an absolute requirement should be made by the rules that the specifications be divided into sections based upon subject matter capable of being divided under separate headings, and such headings should be employed. This would assist the examiner in comprehending the invention, arranging for its proper classification, and enable the patented inventions as references to be recognized in pertinency with greater facility. I would go so far as to require the heading system to be used for claims where the conditions will allow.

I notice in a recent address before the patent examiners that one of the examiners directed attention to the desirability of using numbers as reference characters. I have recognized the difficulty of reading reference letters and combined reference letters and numerals through many years of practice and I trust that a requirement for the use of numbers only will sometime be established as a rule.

JOHN F. ROBB.

Washington, D. C.

The Naval Research Laboratory

To the Editor of the SCIENTIFIC AMERICAN:

Referring to your recent editorial, "A Laboratory—Not a Navy Yard," I think it must have been written under some misunderstanding of what is actually proposed, although very likely justified by the incompleteness of the announcement which was made. I think I may safely say that the Naval Consulting Board is not in sympathy with any grandiose or impractical proposals. Most of its members are, or have been connected with great manufacturing establishments where experimental and development works are continually carried out on a large and increasingly costly scale.

They feel that the lessons of the present war and the scale of preparedness to which the Government is committed necessitate far more extensive basic measures than are now afforded, a conclusion reached after a detail statement of naval facilities was in hand and some personal investigations had been made. To that end what was really advised was the establishment of a Naval Research Laboratory and Experimental Station, not to replace anything now existing which is doing efficient work, but to amplify and in a certain measure consolidate certain developments founded upon research, which may be vital in times of emergency for the quick attainment of results and a possible great saving from serious mistakes affecting any large programme.

Five million dollars is simply the board's judgment of what may be looked forward to as an ultimate cost, extending over a period of years, of an establishment which will meet the future needs of the Navy, but which should be generally outlined now; and the estimate of one half of this amount is likewise the estimate of what might be the annual operating cost of such a laboratory and experimental station when fully developed and utilized. This latter sum would then include from a million to a million and a half dollars now provided for in specific annual appropriations for experimental developments, which by authority of the Secretary of the Navy could be ultimately carried out in the new establishment to the relief of other much crowded facilities.

The capital estimate also contemplates the possibility of land purchase, which might possibly be avoided, although it should not be if for the purpose outlined some special situation has decided advantages. For the moment, excluding from consideration such land purchase, I believe it is the general belief that the appropriation for the current year, to be expended under the authority of the Secretary of the Navy, after plans of the buildings and equipment are sufficiently advanced, would not be over about one million dollars for both, but it ought not to be less, and for the first year's operation, say, five hundred thousand dollars.

There is not the slightest intention of encroaching upon the special provinces of existing facilities, as, for example, such a splendid institution as the Bureau of Standards, whose initial purpose was the establishment of standards but which has widened its sphere of usefulness so that it now carries on research work of the highest order, much of its general work being for the public.

But every man active in the mechanical arts knows that in addition to whatever patient and invaluable research may be carried on it is often imperative to conduct on a large and costly scale practical tests of apparatus because the time saved at critical periods often justifies what might at first glance appear excessive expenditure.

I think it will be found that with this understanding the Secretary of the Navy is only asking for the inclusion in this year's estimates of the modest sums indicated in this communication for this purpose.

The members of the Naval Consulting Board highly appreciate and value the support of the technical journals of the country, and it is to be hoped that at no time will there be any misunderstanding as to what its real purposes are.

FRANK J. SPRAGUE.

New York city.

"The Monstrous Tyranny"

To the Editor of the SCIENTIFIC AMERICAN:

I have just read with much interest your article in this week's issue on Von Tirpitz and his Navy.

I think I understand correctly the intended connection between the expression "the monstrous tyranny" of the British fleet and the "psychology of the German mind," but is it not possible, if not probable, that there exists in the minds of many a confusion as to the menace contained in a Navy as contrasted with that of a Continental Army. England's specialty is her Navy, Germany's her Army, but in the very nature of the case is it not really self-evident that in the case of an island Empire a Navy is nothing but a defensive force? No ship can possibly attack the real forces of a Continental power. It is not possible for a Navy to constitute a "monstrous tyranny." It is also true that a Continental Army cannot be a "monstrous tyranny" to an island Empire with a superior fleet, but as concerns the other Continental nations it will always be that very thing. Is it not a fact that the psychology of the German mind has really created a bogey of their own imagination in reference to the British fleet, but that in reference to the rest of Europe their own Army at least contains the possibility of a most monstrous and dangerous tyranny?

EDWARD P. OWEN.

Genoa, Colo.

Loading an American truck on a steamer bound for Europe

Unpacking a consignment of American trucks in France

Motor Trucks and Modern Warfare

Increase of American Exports. Subsidy Systems of the Warring Nations

By Joseph Brinker

NAPOLEON said that an army travels on its belly. This is just as true now as it was in the time of the great Emperor. The army of to-day travels faster than ever before. Its belly moves on motor trucks instead of horses.

Perhaps the most interesting example of motor trucks in this work is that of the Paris motor buses. With 500 of these vehicles transformed into meat wagons by boarding over the windows, 750,000 men are supplied with fresh meat daily. The load of each bus is made up of approximately 4,000 pounds of meat which is sufficient for 3,600 rations of 1.1 pounds each. Although only one half the number used, or 250, are considered necessary theoretically, the others are maintained to assure a regular service and to allow for all the unforseen circumstances of war.

Although the Paris motor buses have now been in active service for more than 12 months, the percentage of failures due to mechanical troubles has been very small. This is due in a great measure to the fact that all these vehicles are employed in convoys with no other types and that the drivers are the same men who operated them in civil life on the Paris thoroughfares.

All these buses were in the army service one hour after the notice of mobilization had been posted at 4 o'clock on the afternoon of August 1st. Each driver completed the trip he was making and then drove directly to a predetermined point in the city where each vehicle was loaded with either men, ammunition or food for the frontier. This was done without hitch, for France has an institution known as the "Service du Train des Equipages," which is fully posted as to the condition of every motor vehicle in the republic, its owner and driver. This information is all enrolled in the plans for mobilization.

The armored motor vehicle, consisting of either a motor truck or a passenger car chassis carrying a light, small-caliber gun protected by thin sheet plating, has played an important part in the modern method of warfare. This was especially so in the fighting among the sand dunes of Belgium where speedy vehicles of both the Allies and the Germans made spectacular raids into the enemy's country, inflicting severe damage on the opponent's infantry and then making a quick escape before they could be badly damaged.

Some of the German types weighed from 8 to 10 tons and were actually traveling fortresses with the guns, men and the vital parts of the vehicle itself protected by heavy steel plating. While these might have been of great value if the march to the doors of Paris had been carried out over the main roads in August as per schedule, they soon lost their effectiveness by becoming mired in the mud on the second-rate roads a month later after rain and frost had got in their work.

As a result, the extreme type or traveling fortress, has been proved unsuitable for present war conditions and two new types have been evolved. The first is a powerful touring car or a truck of 2-tons capacity, completely incased, but with the total weight kept as low as possible. The second is a four-wheel-driven truck of the same capacity but so arranged with drivers' seats and steering wheels on both ends that it can be driven from either end. When cornered on a road where it is impossible to make a turn quickly, the car can be run backwards out of danger's path at the same speed at which it can move forward. This type of armored motor truck, although comparatively new, was embodied in the fast touring cars of smugglers used for several years past in getting untaxed goods across the Franco-Belgian frontier.

None the less important than the work done by these speedy trucks equipped with light armor and small-caliber rifles is that rendered to the fleets of aeroplanes which have proven of such great value in the strategical disposition of the troops of both opponents. On both sides, these fleets are divided into several groups according to the type of machine. These, generally kept several miles behind the actual firing line, must nevertheless be moved quickly in a retreat to avoid capture.

The French Army has several hundred motor vehicles for this work alone. The aeroplanes are divided into divisions according to the type, each division having only machines of the same kind. Seven or eight aeroplanes make up one division. The light monoplanes have fairly fast passenger cars and light rubber-tired trailers upon which the flying machines are towed after having their wings folded back. These vehicles also carry spare parts such as propellers and motor fittings and act as repair shops when the flyers are damaged. When being hauled from point to point, both the truck and the aeroplane are covered with dark green tarpaulins for the purpose of enabling the entire equipment to camp out in the shadows of trees with very little chance of being discovered by aeroplanes of the enemy.

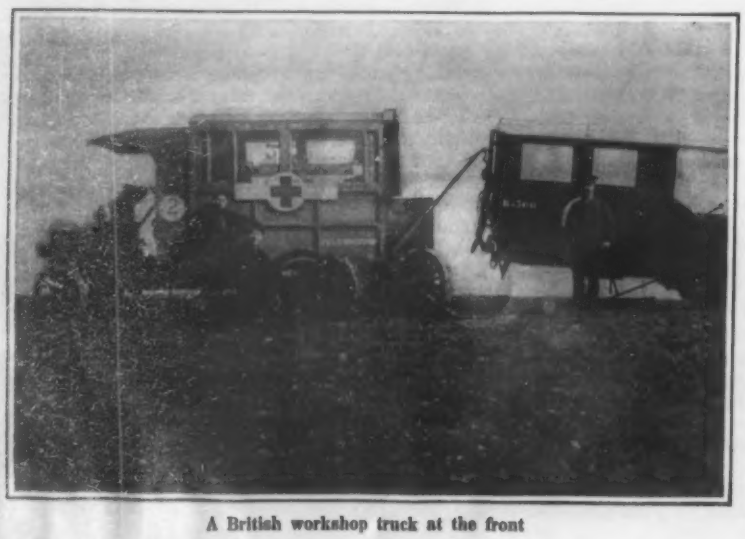
Many thousands of trucks and passenger cars are being used by both sides as ambulances. While there was a great shortage of vehicles with bodies of a suitable type for this work at the outbreak of war, this has been remedied and it is now possible for a wounded soldier to reach the temporary hospital several miles back of the firing line in less than an hour, when under the horse-ambulance régime, it often took half a day.

Some of the types used by the British Army consist of heavy passenger cars or light trucks with a canvas body and mica windows on each side. Four to six stretchers may be placed in each body in rows of two or three, one above the other on each side, with a vertical aisle between. The physician or surgeon rides in this aisle and is thus able to watch all the wounded at the same time and to render any necessary aid. France also has a large fleet of vehicles of a somewhat similar type of design. She also uses many of the closed-body trucks returning from the trenches after having unloaded food or ammunition. Stretchers are slung from the roofs of these vehicles and while this method has the advantage of getting the wounded away quickly, it offers little in the way of comfort.

Export of American Cars

At the beginning of the war there were approximately 250,000 motor vehicles with the armies of the five belligerent nations, of which slightly less than 100,000 were trucks.

Since that time the Allies have imported from this country up to and including the month of June, 14,446 motor trucks of all sizes and valued at the tremendous sum of $39,230,282. With the exception of the month of January, 1915, the exports have steadily increased from 66 vehicles valued at $124,016 in August, 1914, to 1,502 valued at $3,220,482 in February, 1915.



A British workshop truck at the front

Subjecting a truck to a rigid test in France

While only 1,339 were shipped in March, 163 less than in February, they were valued at $4,723,563, or $1,503,081 more than the larger number of the month previous. The June record of 2,990 trucks valued at $8,578,802, is a world's record for the exportation of motor trucks from any country.

The exports of American-made trucks to all the warring nations of Europe, month by month, have been as follows, according to the Bureau of Statistics at Washington, D. C.:

Month	Number	Value
August, 1914	66	$124,016
September	128	294,288
October	672	2,286,964
November	842	2,244,518
December	1,279	3,387,729
January, 1915	935	2,545,527
February	1,502	3,220,482
March	1,339	4,723,563
April	2,207	5,240,481
May	2,426	6,583,912
June	2,990	8,578,802
Totals	14,446	$39,230,282

Besides these exports of trucks there also have been large shipments of passenger car chassis, amounting to 23,880 valued at $21,113,953 for the 12 months ending June, 1915, some of them with conventional bodies for the use of officers and members of the staffs and others with ambulance bodies for Red Cross work. To the above must be added perhaps a thousand or two trucks and passenger cars shipped to Canada and Australia which eventually found their way to the fighting line on either the Eastern or Western front.

With these, the total shipments of both passenger cars and trucks exported from this country amount to approximately 38,000, of which about 15,000 are trucks.

Add to these 15,000, the 100,000 owned and commandeered by the five belligerents at the beginning of the war and approximately 5,000 more which have been built abroad since the conflict began and we have approximately 130,000 trucks actually in service at the front! These trucks lined up in one long convoy, with the ends of each touching the preceding one, would form a line approximately 425 miles long, a line long enough to reach from New York to Cleveland or from Pittsburgh to Chicago!

Subsidy Systems in Europe

While everyone is cognizant of the fact that England, Germany and France all subsidize their great merchant marines, it may not be generally known that the motor trucks in each of these countries are under a subsidy just as comprehensive and far-reaching. Any motor truck owner in any of these countries may subsidize his truck and receive therefor a certain stipulated sum each year for a period of years, provided he will surrender his vehicle to his own particular government in time of war.

Although the British were the first to make use of motor transportation for war purposes, the French were the first to subsidize their motor trucks. The British made very extensive use of motor vehicles, especially steam trucks, in the South African campaign. The Italians were the next to realize the great possibilities of power-driven vehicles for war purposes, using more than 200 in the fighting in Tripoli. The rapid advance of the Bulgarian Army almost to the gates of Constantinople in the recent war of the Balkan states was attributed to the large number of motor vehicles used. The Greeks and Serbians also made good use of motor transportation in the aftermath of the latter war.

The French established their truck subsidy in the early part of 1906. The British were next in seniority, introducing theirs in 1912, while the Germans passed a similar law in 1913. Shortly after the German subsidy went into effect, Austria put into force one of similar nature. Italy has only recently begun the installation of a motor truck subsidy, those vehicles used in Tripoli having been purchased outright. Russia has no subsidy of any kind, due mainly to the fact that she has no truck manufacturing industry.

The subsidy systems of the Germans and Austrians differ from those of the British and French. The former lay great stress not on single trucks, but on those which are capable of carrying additional loads in trailers.

The French system is perhaps the best, because it was begun six years before the British and seven years before the German. In these intervals, the French carried out extensive tests each year of all the subsidized vehicles and eliminated weaknesses which manifested themselves. The similarity between the British and the French systems ends with the power to requisition all subsidized vehicles in cases of war. From this point on, it is not a question of the development or of the technical value of British and French trucks, but of their adaptability to military purposes. In this respect France is far ahead of England.

Although England has developed its motor transportation very thoroughly, it has been only in the requirements of the commercial user and not for the war department. This is so because when the British authorities became alive to the value of motor trucks, they had to deal with a highly-specialized industry which had endeavored to produce vehicles designed to give the best results to the commercial user without taking military requirements into consideration.

The subsequent British specifications, while in themselves not unfair, practically made it imperative for manufacturers and users to abandon their designs and detailed features for various kinds of work, no matter how good they might be. As a result the subsidy scheme was not received favorably. The indifference with which it was taken up was shown at the last British Army trials which brought together but three vehicles while the last trials of the French Army had 100 trucks.

Because of this indifference, the fleet of subsidized trucks commandeered at the outbreak of war by the British authorities was a motley array of all types and sizes and speeds. Hence the fleets of British convoy trucks were continually in trouble; some trucks could not maintain the required speed and others had to stop for fuel and oil at varying points. These two conditions decreased the convoy efficiency considerably and made it impossible for it to act as a unit. On the other hand, the French who had taken up the question of subsidy before trucks were actually a commercial success, had been able to have the manufacturers incorporate the military requirements in their designs.

However, the American motor truck user has no idea of the exactions of the tests which the French trucks must undergo before being accepted by the government. These tests have been so severe that less than a dozen manufacturers have been able to secure the subsidy for their vehicles. All makes are eliminated which have not been designed and built to withstand the greatest abuse to which a motor-driven vehicle may be subjected.

The tests for the acceptance of the vehicle include a continuous 30-day observation usually held at the annual army maneuvers. In these trials, the slightest distortion or breakage of any of the mechanism, even so much as a bolt, would disqualify that vehicle for a subsidy. The motors must run equally well on gasoline, benzole or alcohol, so that in case of the shortage of any one of these fuels in time of war, the vehicle may run on the others without interruption. Trucks eligible range from two to seven tons in capacity. The minimum average speed required is nine miles per hour.

The French subsidies average about $600 per vehicle, depending upon the weight of load carried. This sum is paid the owner by the War Department immediately after the latter has proven by tests that the vehicle fulfills all the necessary requirements. In addition to this sum, each owner is paid a yearly bonus of approximately $200 for four consecutive years, thus bringing the total subsidy per truck up to about $1,400. In the case of a 3-ton truck, this amounts to approximately 40 per cent of the purchase price. During 1909, France awarded $375,000 in subsidies; in 1912, $600,000 and in 1913 almost $750,000. The number of French subsidized trucks at the beginning of the war was close to 4,000.

The British subsidy, while like the French in that trucks with and without trailers are admitted, differs in that the cash payments are only about one third as

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American truck for the European war undergoing a weight test

American car in the service of the French Army

Carrying food to the British supply bases in France

Photo by Brauger

Car and trailer for transporting an aeroplane

The Dyestuff Famine.—I

Its Causes and Its Cure

By Prof. Thomas H. Norton, Ph.D., Sc.D., Bureau of Foreign and Domestic Commerce, Washington

THE past twelve months have witnessed far-reaching and almost revolutionary changes in the economic life of the nation. Financially it has so fortified its domestic system of credits and reserves that it can bravely face those fluctuations in commercial activity which a few decades ago inevitably spelled ruin for thousands. In the field of international exchange the American dollar seems destined soon to displace the British pound. Politically the United States is the recognized leader of an extensive group of nations—the neutral powers—in the midst of the greatest conflict known in the world's history.

The reflex action of this tremendous but deplorable struggle is evident in every phase of our national life, and especially in the field of industrial effort. In no section of this field has the influence of transatlantic conditions produced such momentous results as in the manufacture and consumption of artificial colors.

Let us note the changes which have occurred since August, 1914.

At the outbreak of the present European war, the textile and other allied interests of the United States were threatened by a shortage in the supply of dyestuffs. For some weeks shipments were entirely suspended. Gradually, as the result of the most strenuous efforts on the part of leading representatives of the textile industries and of the firms engaged in importing artificial colors of foreign origin, the movement was restored to nearly normal figures. The possibility of a complete cessation in shipments was, however, constantly present as a menace, hanging like the sword of Damocles over the head of every consumer of synthetic dyes. The threatened danger arrived seven months ago, when an embargo on the shipments of dyes of German origin to neutral countries came into effect. Since March 15, no wares in this category have been received, except on October 13, when fifty tons of German dyestuffs were unloaded in the port of New York—almost enough to meet the industrial needs of the nation for a single day. During nearly all of this period of seven months there has been in force a permit, issued by the British Government, allowing free passage to the United States of two steamer loads of artificial colors of German origin. Thus far the German Government has steadily refused to allow this supply to pass out of the Empire, unless a *quid pro quo* were accorded in the form of a shipment from the United States to Germany of an equivalent amount of cotton or of nitric acid.

This deadlock still exists. During the past seven months small quantities of coal-tar dyes of Swiss origin have reached the United States. The amount has been very limited, but it has been most welcome.

Action of the Department of Commerce

On February 20th of this year, pursuant to a resolution of the Senate, I placed in the hands of the Secretary of Commerce a full report on every phase of the dyestuff situation. Attention was forcibly drawn to the serious risks involved in so complete a national dependence upon foreign sources, for a class of products vitally essential to the very existence of our textile interests. This report was widely read. The first edition was exhausted in ten days.

On May 1st, I was instructed to study carefully existing conditions in the dyestuff industry. An exhaustive report on this subject appeared May 17th. It, also, passed into a second edition.

In the concluding paragraphs of this report, it was shown that the available stock of dyes of German origin would probably be exhausted before the close of the Summer. Strong emphasis was laid upon the imperative necessity of making timely provision for such a blow to the country's textile and allied industries. The prompt use, on an extended scale, of vegetable dyes was urged; and the pressing need of economy in the employment of coloring materials was fully demonstrated.

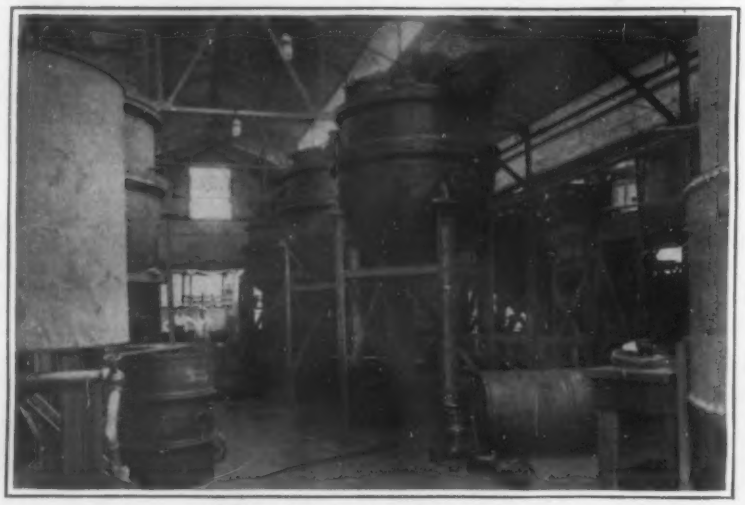
The Present Situation

As a matter of fact, the warning was heeded. Every possible device was called into play to reduce the quantity of dyestuffs used. The average textile mill has husbanded its stock of colors so as to make it reach until about October 1st. Since then the pinch of a widespread "dyestuff famine" has been increasingly felt. One mill after another has been forced to close entirely, or in part.

A single instance is typical. The largest hosiery mill in the United States, (and in the world), employs 2,500 operatives. Ordinarily it requires 500 pounds of dyestuffs daily to cover the needs of its dyehouse. Six weeks ago its stock of colors had sunk to half a barrel. Some 160,000 dozen pairs of hose were stocked up, awaiting dyes. Over 1,000 operatives were enjoying an unwelcome vacation. With considerable difficulty the manager has secured a ton of aniline oil to use for aniline black, at a cost per pound of $1.50. (The price in July, 1914, was ten cents!)

The files of my correspondence show that similar conditions exist in all branches of industry involving the factor of color. In every sense of the word, American textile and allied interests are facing an acute "dyestuff famine." The occasional arrival of small lots of Swiss colors, or of other artificial colors, secured by various means in out-of-the-way corners of the world, serves only to accentuate the acuteness of the situation. South America and the Far East have been searched with a fine tooth comb, as it were, for this purpose.

Nitrating section of an aniline dye works



Sulphonating section of a dye factory

What the Government is Doing

The question naturally arises in every quarter: What has the Government done to alleviate the hardships of such a famine, and what is it now doing?

The reply may be briefly formulated. Only two Departments of the Government come into consideration in this connection. The Department of State has exerted every possible effort to secure the free passage of German dyestuffs to our ports. It is continuing its efforts without relaxation. The Department of Commerce published in March, 1915, an exhaustive study of the dyestuff situation in the United States, presenting all the factors in the case. In May, 1915, it warned all industries concerned of the impending dangers. Since last February it has done all in its power to inform consumers of colors how they can most easily lessen the hardships incident to a shortage in dyes. It has inculcated economy in the use of dyestuffs generally. It has pointed out the desirability of employing natural dyestuffs on the most generous scale. It has encouraged and stimulated every undertaking promising to add even the smallest amount to the available dyestuff supply. It has done all in its power to prevail upon capital and enterprise to enter the field of coal-tar chemistry, to increase the supply of coal-tar "crudes," to multiply the production of intermediates, to broaden and intensify the output of American-made, finished dyestuffs. It has brought together inventors and capitalists, the producer of colors and the consumer of colors.

It has recognized the fact that all industries, dependent upon the factor of color, must suffer more or less from the existing conditions, and has urged a mutual spirit of conciliation and compromise, between the consumers of colored fabrics and articles and the producers of these wares.

The Chemists' Magna Charta

On September 30, the press of our land contained a brief communication from the Secretary of Commerce. In a few crisp, clear-cut sentences, it formulated what American color chemists may perhaps some day term the Magna Charta of their rights. It outlined in unmistakable terms what the policy of this present administration will henceforth be, as regards the protection of American enterprise and effort against unfair attempts on the part of foreign rivals to crush competition.

So clearly and forcibly has the longing of the incipient national industry found expression at the council board of our chief magistrate, that its leaders can now confidently look forward to the moment when the President of this republic shall affix his signature to a law making as impossible in foreign trade, as it is in domestic trade, any attempt to crush, stifle and throttle a new industry on the part of competing rivals beyond the seas.

It remains now to outline what has actually been accomplished toward a material alleviation of the hardships of this period of famine through which we are passing, and to what extent the foundations are being laid for an independent American coal-tar chemical industry.

How We Are Meeting the Famine

The present dyestuff famine has made unusual demands upon the adaptability and ingenuity of the American people. It has involved readjustments all along the line, throughout the entire sequence of links connecting the cotton fields of our Southland, the flocks of sheep in distant Australia, the feeders of silk worms in the Far East, with the gaily-apparelled throngs on our streets. The problem is being attacked from three different angles.

Increase in Output of American Coal-Tar Dyes

In the first place, the few existing American establishments devoted to the manufacture of artificial dyestuffs have notably increased their production. Prior to the war, they made a somewhat limited amount of coal-tar colors. The annual output was about 3,000 short tons. For the purpose of their manufacture, intermediates were imported, chiefly from Germany. These were assembled into finished dyes by the aid of a few American chemicals and the labor of not over 400 workmen.

With the nearly total cessation in the importation of intermediates came the necessity for a complete revolution in the organization of the limited American industry. Prompt and resolute decisions were made. Great sums of money were invested in new plants. Before the war was twelve months old, the output of American coal-tar colors had doubled. Too much praise cannot be given to the men who accomplished this *tour de force*.

This involved a notable increase in the production of coal-tar crudes. It also called into existence a number of new companies engaged in the manufacture of intermediates, especially of aniline.

The domestic supply of benzol has assumed large proportions. The output now is five times what it was before the war. It has naturally been accompanied by

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Handless soldier learning to become an engraver

Learning to help themselves with artificial hand

Learning to write with an artificial right hand

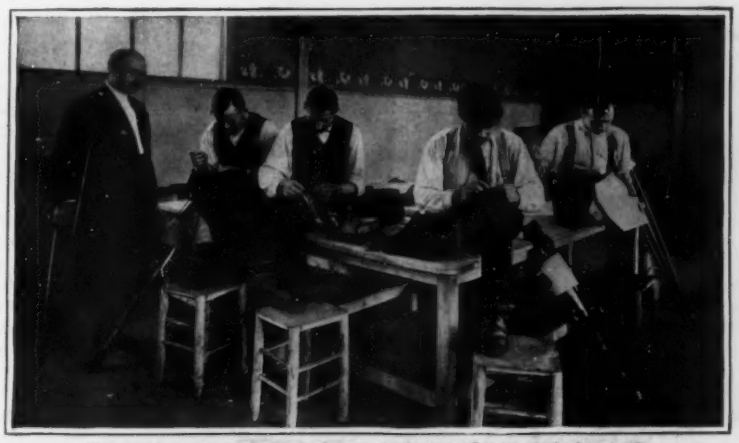
Training of the War's Maimed, Halt and Blind

How the Fighting Nations Are Meeting This All-Important Problem

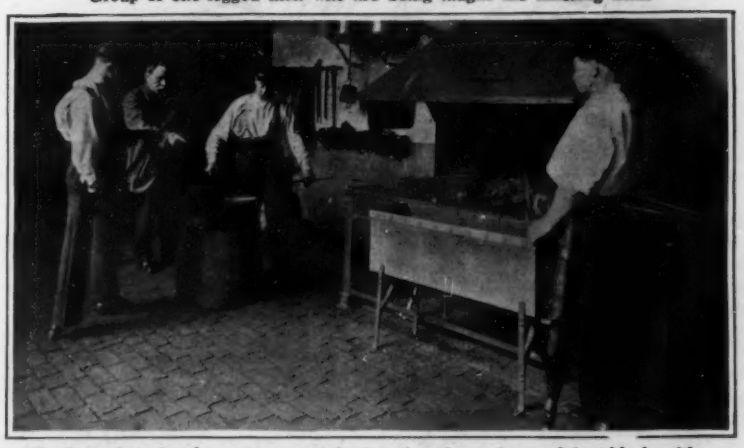
THE staggering numbers of men killed in the battles of the present war quite overshadow the great numbers of unfortunates who have been crippled and thus seriously handicapped for the balance of their lives. To these men the respective governments owe a debt: Either the men must be pensioned for the remainder of their lives or they must be trained to some new trade that will enable them to earn a livelihood. Disregarding the difficulties of pensioning the multitudes of crippled men this war is constantly producing, it is still necessary to train the men since they themselves do not wish to become public charges, but rather ask to earn their living in whatever manner possible, as before.

A man who is suddenly rendered a cripple through any cause finds himself in much the same position as a child. He must begin learning all over again how to make use of his remaining limbs for new purposes. Many tasks of daily routine must be mastered as in childhood, such as how to hold and use a knife, fork or spoon, how to write, and how to use the numerous devices and implements encountered in every day routine. The government, for whom the cripple has sacrificed so much, assumes the task of instructor to each man, teaching him how to accustom himself to the new order of things as well as some suitable trade in which he can earn enough to support himself and possibly others dependent on him.

The resourcefulness of the European countries in training their cripples and blind for new trades is little short of amazing; certain it is that nothing approaching it in magnitude and results has ever been witnessed before. The capabilities of the unfortunates are being carefully studied and a trade selected which is best suited to them. In unusual cases where no existing trade seems to fit the man, special work is devised. In fact, it is particularly in the latter phase of the work that the greatest ingenuity has been displayed.



Group of one-legged men who are being taught the tailoring trade



The loss of one leg does not prevent the men from becoming proficient blacksmiths

Erstwhile outdoor laborers and others requiring the use of their lower limbs and who have been deprived of the use of one of these limbs in battle are now being taught some indoor occupation. One-legged men are being trained to do all kinds of work with their hands, among the trades taught them being tailoring, blacksmithing, shoemaking, and operating machinery for making various products.

The Viennese architect, Grosselfinger, though bereft of his right arm, has nevertheless since his university days been able to follow his calling without hindrance. At the outbreak of the war he sought to put his experience at his country's service by opening a special school for the one-armed, where they were to be taught how to work comfortably at a life-sustaining trade. Following his plan, other schools have been founded, notably at Heidelberg in Germany, under the guidance of Dr. Vulpius. Such a school can furnish a soldier, whose maiming has precluded his working at his former trade, with the knowledge and training necessary to a change of occupation. The pupils are enjoined to manage independently all the affairs of daily life: they learn how to dress, shave, wash and feed themselves. Physical exercises are provided to strengthen the stump and to develop special aptitude and strength in the sound

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One-legged men at work soldering tin cans in a can factory

One-legged man being taught the cobbler's trade

Path of the hand in drilling, before motion study instruction (at left) and after instruction (at right) when a special stand (center picture) was used to bring the pieces automatically into position, and an inclined chute carried them to the tote box on the floor

The Industrial Coach

How the Efficiency Engineer Studies the Human Machine

Film showing assembly of machines for making shoe strings. Note the micro-chronometer measuring thousandths of a minute, and the common clock alongside

MAN is a multi-purpose machine. He comprises an aggregation of complex mechanism adapted to an endless variety of operations, together with a directing brain to choose the particular mechanism required for the work in hand, and to select the methods of procedure or sequence of operations. Because of the variety of mechanism at their disposal, a hundred operators will do the same piece of work in a hundred slightly differing ways. The mechanical machine, on the other hand, is designed for a set series of operations which have been fore-ordained by the designer of the machine and from which it cannot vary. It is a single-purpose machine. If it does its work well we describe it as efficient. We never speak of a skillful machine, because it has no power of choice. The skill is shown, rather, by the designer of the machine in choosing and combining the mechanism and mechanical movements for the work to be done. On the other hand, a human machine may be skillful, and to call a man skillful is to pay tribute to his good judgment in directing his own physical mechanism. To be sure, his dexterity and general efficiency may be due in a measure to development of muscles and senses, by long practice, and continued repetition may have trained his members to perform the work quite mechanically, but at the outset he must have passed through a stage of progressive experiment when he learned to eliminate this bit of uncertainty or that awkward or purposeless motion, when he found out how to grasp the work to better advantage, how to arrange a more convenient order of operations, how to do several things at once, etc. It is only because there are many hundreds of ways of doing a piece of work that we can rate one person as more skillful than another. He may acquire skill by his own experience, but the chance that he will hit upon the best method is decidedly remote. Only by a minute study of the work of hundreds of others and by selecting and adapting the best of the best may the standard be raised to the highest notch.

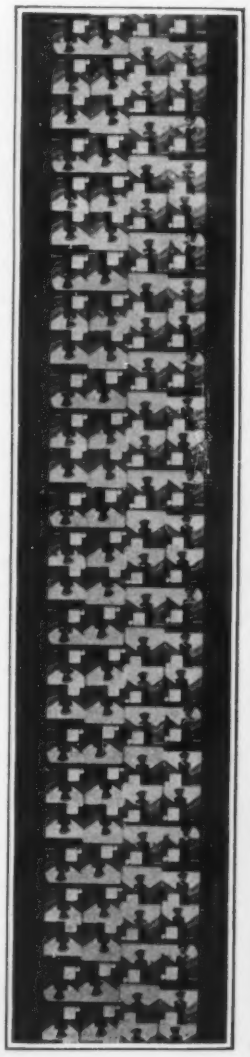
In amateur and professional sports where competition is keen, a coach is indispensable. We are coming to realize that this is just as important in industrial operations. Certainly where there is keen competition, the manufacturer who employs a good industrial coach will forge ahead in the race.

There is a great deal of prejudice against the industrial coach or "efficiency engineer," as he calls himself, because he undertakes to coach a man in a line of work that he has never practiced. We are apt to forget that there is a vast difference between performing and coaching. Experience has taught that no athlete is so good that he cannot improve with coaching. The fact that he can box better, run faster, vault higher than his coach is quite beside the point. Even the champion needs coaching. A good football coach may never have played on a college team and a successful swimming teacher may actually be unable to keep afloat.

Some time ago, Mr. Frank B. Gilbreth made a careful study of the work of brick layers. Noting carefully the various operations, the character of and time consumed by each motion, he discovered that a vast amount of waste effort was expended, and he worked out a system by which this waste could be eliminated. Then he coached a group of men, and as a result of his training, they were able to turn out three times as much work as before, and this with no more fatigue.

Then Mr. Gilbreth suddenly awoke to the fact that his own system of work was very inefficient. His practice had been to use a pad, a pencil and a stop watch. He would observe a certain operation, look at the watch to note the time it took, then jot down a memorandum on the pad. But while he was writing this memorandum, he might have missed and probably did miss a number of other important motions. Evidently a more efficient system of motion study was requisite. Naturally the first suggestion was the use of the motion picture camera. This was tried out with excellent results; for it gave a continuous record with no time gaps except the slight intervals between pictures, and later even these intervals were eliminated by the use of a double kinematograph, the pictures of one overlapping those of the other. By using a clock and a microchronometer recording the thousandth part of a second and photographing them with the operations, the exact time of their duration could be recorded. By this system, motions could be studied minutely because they could be repeated at will upon the screen. Furthermore, the film could be used in the lecture room of the foreman's club to show workmen just how they did their work and what waste motions were included in the operation. It is interesting to note that football coaches have adopted this suggestion of the more scientific industrial coach, and by taking moving pictures of the contesting teams, they are able to study minutely the work of each individual member of the team and note his merits and his shortcomings.

Having a perfect record of the path of motion and



Film with sixteen pictures taken in the space of one. When thrown on the screen the pictures are large enough to show the time clearly

Taking an automatic, stereoscopic micro-motion picture of himself

Making a wire model of a cyclegraph

the time, it was necessary to have some measure of distance as well. This was obtained by performing the operation on a cross-sectioned table and before a cross-section screen. By means of a double exposure, it was possible to show a vertical, phantom cross-section screen in the very plane of the work or even in the foreground.

However, one of the chief drawbacks of the kinematograph was the cost of the films. It occurred to Mr. Gilbreth that for purposes of study it was not necessary to take photographs of the size commonly used for projection on a large screen. Accordingly, he devised a type of shutter which could be placed directly before the film, so that only a portion of it would be exposed. After the entire run of the film in one direction, the reels were transposed and the film was run back in the opposite direction with another portion of the film exposed to the lens. By this means, four pictures could be taken in the space of one. Later the number of exposures was increased to eight, then sixteen, and finally to twenty-four, so that a single reel could do the service required previously by two dozen.

While this was an important step in advance, it did not completely satisfy all requirements. What Mr. Gilbreth wanted was a graph or a continuous line, indicating the path of motion of the particular part under consideration, be it hand, foot, finger, head or other member. This led to the invention of the cyclegraph. If the motion of the hand was to be studied, a small electric lamp was attached to the hand and connected by flexible wires to a suitable source of electrical energy. Then, when a photograph of an operation was taken, the path of the hand would show as a line of light. By taking stereoscopic pictures, it was possible to follow the motion, not only in a plane of the picture, but also in relief.

This served very well for noting the motions of a single hand, but in a more complicated operation, where the motions of two hands were to be observed, it was necessary to distinguish one from the other. Consequently a form of interrupter was introduced in the circuit of each lamp, so that the lamp on the right hand, for instance, would show a series of flashes that would appear in the photograph as a dotted line, while a different form of interrupter in the circuit of the left hand lamp would cause that to produce, in the photograph, a dot-and-dash line. A large variety of interruptions could be introduced where a number of lamps were to be used, so that it was possible to photograph simultaneously the motions of several members of the human machine and distinguish each from the other. Furthermore, by using an accurately timed interrupter which would produce a certain fixed number of make-and-breaks per second, the time consumed in performing the motion could be estimated by counting the number of dots and dot-and-dashes in the cyclegraph. This lead to the name "chronocyclegraph" to designate a photograph in which the motion was indicated by a line of timed flashes.

There was still one more improvement necessary. While the chronocyclegraph recorded the exact path and time of a certain motion, it was often impossible to tell in what direction the hand was moving. A knowledge of the direction of motion is indispensable, sometimes, to a complete understanding of an operation. This difficulty was overcome very ingeniously by the selection of lamps with thick filaments, which under a proper combination of voltage and amperage would light up very quickly, but would die out comparatively slowly when the current was interrupted. This produced a dot that tapered in the direction of the motion. In other words, the dotted line appeared as a series of small arrowheads, all pointing in the direction in which the lamp was moving. The word "stereochronocyclegraph" has been coined to designate a photograph showing such a dotted line.

Every requirement was now fulfilled. It was possible to photograph a certain operation and have a record, not only of the path of motion, but also of the time it took, the distance it covered, and its direction. With such a record, photographed by a stereoscopic camera, so as to show motion in three dimensions, the student has all he needs to make a complete study of a certain operation. If desired, an enlarged model of a cyclegraph may be made of wire with dots or dot-and-dashes painted on it, so that it may be exhibited before a class room and be subjected to minute analysis.

By means of these methods of recording motions, Mr. Gilbreth recently made a study in a factory where handkerchiefs are manufactured. He took, as his study, the folding of the handkerchiefs, and found that there was a great variation between the work of the different girls. In the case of one girl, he found that the two hands went through a hundred and fifty motions. After studying the situation and coaching this particular girl, he trained her to do the same work in but fourteen motions. Of course, the output did not increase in the proportion of fourteen to one hundred and fifty, because the new motions took on an average, a longer time, but there was a decided increase in output in the ratio of about fourteen to fifty. In other words, fifty handkechiefs could be folded in the time that had previously been required to fold fourteen.

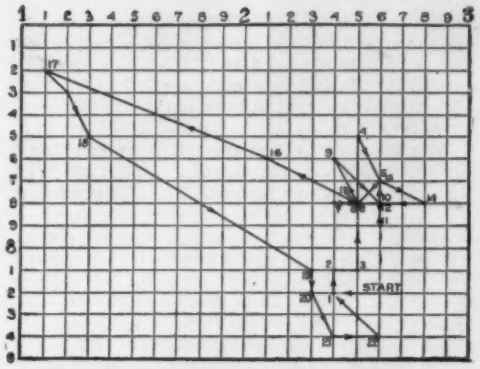


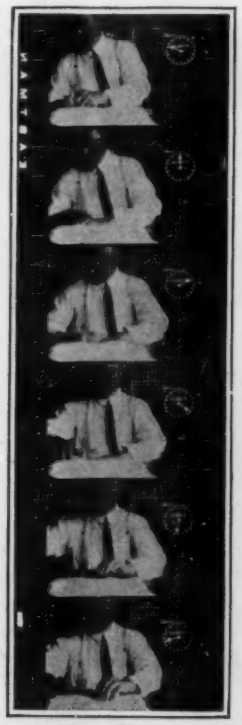
Chart showing motion of typist's eye when the copy is at the right of the machine

A further development of Mr. Gilbreth's system is the "automatic, private time study." A special apparatus has been designed whereby at the touch of a button, one may start a motion picture camera operating and make a record of his own motions. With another apparatus a man may take stereoscopic pictures of himself while he has his hand fitted with chronocyclegraph lamps, so that he may make a record of any particular motion or operation that he wishes to study. This permits one to analyze his own operations in a room by himself where he is not annoyed or affected by the presence of an outsider.

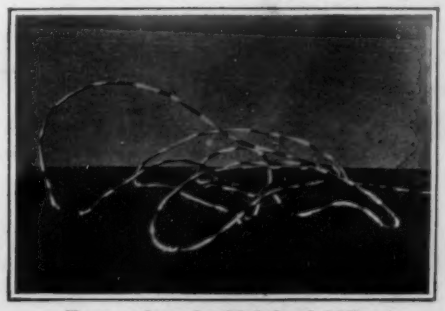
The use of this special recording apparatus is of particular interest to psychologists, for, by its means, they have been able to make many very interesting studies.

Not only must the efficiency engineer study the motion of operators, but he must also study fatigue, as this has a very important bearing upon the economy of an operation. Few of us realize how important a factor in fatigue is the eye. If the eyes must be rapidly shifted from one position to another, a person soon experiences considerable fatigue. In the study of eye motions, it is difficult to use the chronocyclegraph, but in this emergency motion picture photography has been found very useful. The eye of the operator is exposed by drawing the lids apart and then a beam of light is directed upon the eyeball and it shows as a tiny spot in the photograph. This is, to all intents and purposes, a fixed reference spot which does not vary appreciably as the eye is turned. The motion of the eye is then studied by measuring from the center of the pupil to this reference spot on successive pictures of the film, thus obtaining values which are plotted on a chart. The accompanying drawing illustrates the motions of the eye of a typist, who places her copy at the right side of the typewriter. Mr. Gilbreth's studies show that motions of the eye are greatly reduced by placing the copy directly over the machine, with a corresponding reduction in fatigue.

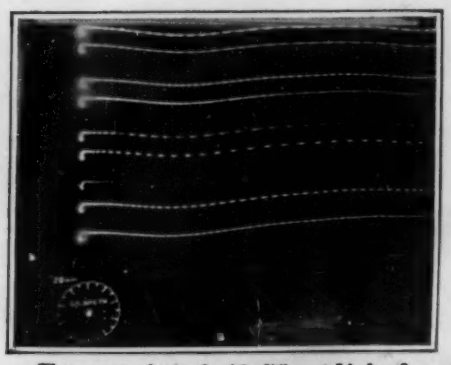
With all these methods of study and instruments of precision at his disposal, surely the industrial coach is now well equipped to detect and eliminate the prodigal waste of effort that is going on in every line of industry.



Film with a phantom, cross-sectioned background



Chronocyclegraph of left hand folding a handkerchief



Time spots obtained with different kinds of chronocyclegraph interrupters

The Current Supplement

MUCH interest has been aroused recently by the report of the safe arrival on the other side of the Atlantic of five submarines of American design that were built in Canada. A picture of these boats, undergoing their finishing touches, will be found on the front page of the SCIENTIFIC AMERICAN SUPPLEMENT No. 2079, for November 6th, 1915. A paper that will be of value to many a young chemist, and a useful summarizing of an important subject for the more experienced, is that on the principles underlying the choice of standard weights of elements. A short abstract of a paper explaining the various factors affecting the accuracy of fire of big guns is timely. A novel idea is a plan for proportioning the machine to the size of the man who is to use it in preparing designs. There are explanatory diagrams. A few illustrations convey information in regard to field telephones used by the French. Applied chemistry is the title of a paper by a leading authority that discusses what the chemist has done for humanity, and his relations to manufacturers. It is a decidedly timely topic. Some description of several remarkable automatic devices that are almost human in their operation will interest all, especially those of inventive genius, particularly as diagrams give a clue to the principles employed. A plan for a district sanitary disposal plant contains suggestions for the consideration of all dwellers in cities. The story about myrtle wax calls attention to a natural product that has generally been allowed to go to waste. There is an article on glucose and its uses which affords a great deal of information on this greatly misrepresented material that will surprise the general reader. The article on the sidereal universe is concluded, and there is interesting matter on the physiological effects of natural gas with notes on the steel industry reviewing conditions in four leading countries.

Poisoning by Aeroplane Varnish

THE enormously increased production of aeroplanes during the war lends point to a warning regarding the varnish employed. At the aeroplane works in Johannisthal a number of workmen employed in the varnishing department were taken seriously ill, and two deaths resulted. The most important symptom was jaundice due to decomposition of the blood. On investigation the cause was found to be poisoning by tetrachlorethane, the only solvent known for the highly combustible acetylcellulose. These accidents led to an order forbidding the use of solvents containing a high percentage of tetrachlorethane.

Assaults on the Inventor's Rights

THE extent to which the patent rights of an inventor may be assailed was well expressed by former Patent Commissioner Holt who once said:

"The citizen can take his stand on the threshold of his home, and with his own right arm beat back those who would invade it; but the rights of the inventor are coextensive with the limits of the Republic, and may be assailed at a thousand points at the same instant of time. The eyes of Argus would not suffice to discover nor the arm of Briareus suffice to resist the assaults of so omnipresent a foe as it is his lot to encounter. The insolence and unscrupulousness of capital, subsidizing and leading on its mercenary minions in the work of pirating some valuable invention held by powerless hands, can scarcely be conceived of by those not familiar with the subject."

The importance of invention to the prosperity of the entire country was beautifully expressed by the first Patent Commissioner Henry L. Ellsworth in one of his early reports in which he says:

"Concede all you claim: free institutions, Christian civilization, industrious habits; grant respect for law; acknowledge all our vast natural resources, and then deduct patents and patented inventions from the causes which have led to this development, and you have subtracted from material, yes, from moral, prosperity nearly all that is worth enjoying.

Penetration of Bullets

Paradoxical Facts Disclosed by Experiments and Study

By Edward C. Crossman

FOUR feet of solid pine boards or four inches of loose dry sand—this is the muzzle penetration of the United States army rifle with the 180 gr. match bullet at the terrific velocity of nearly 2,700 feet per second. Rather lopsided? True, and here are some more figures nearly as surprising:

With the 150 grain service bullet, the American service rifle shoots through 33 inches of dry pine boards at the muzzle, where the velocity is 2,700 feet per second. At 100 yards, where the velocity has fallen to 2,465 feet per second, and the energy decreased from 2,430 foot pounds to 2,024 foot pounds, the rifle shoots through 46 inches of the same pine boards.

At the muzzle, torn to shreds by 4 inches of loose dry sand through which a child could drive his pudgy fist, the service bullet fails to even dent the bottom of a wooden box in which four or five inches of sand is placed. At 1,000 yards, more than a half mile, where the velocity has fallen to 1,008 feet per second, and the energy has fallen from 2,430 foot pounds to 380 foot pounds, this same little bullet gets through about eight inches of dry sand or twice its muzzle penetration.

At the muzzle the service bullet and the heavier 180 grain match bullet fail to see the other side of five inches of loose sand. In steel the service bullet gets through .45 inch at the muzzle. The 180 grain bullet gets through more than a half inch.

Evident it is that here again we find a situation in which things that "stand to reason" don't stand at all when facts come along.

With the advent of the armored train, and then the armored motor car, the question of steel penetration became one of intense interest. The idea of protective steel plating against bullets came with the fighting between North and South along the Mississippi and its tributaries. Eads and Porter evolved the "tin-clads"—gun-boats with a very light protection of sheet iron against the minie balls of their southern friends on the bank—and their southern friends justly were much enraged at this unsportsmanlike attitude.

The old Enfields and Springfields, muzzle loaders of large calibre, had little penetration save in tissue, where their effect was very satisfactory to the gentlemen who had speeded them on their way. The best of them would not get through ¼ inch of sheet iron at 200 yards, while dry white pine boards to the thickness of 16 inches, headed off the bullet from farther viciousness at the same range.

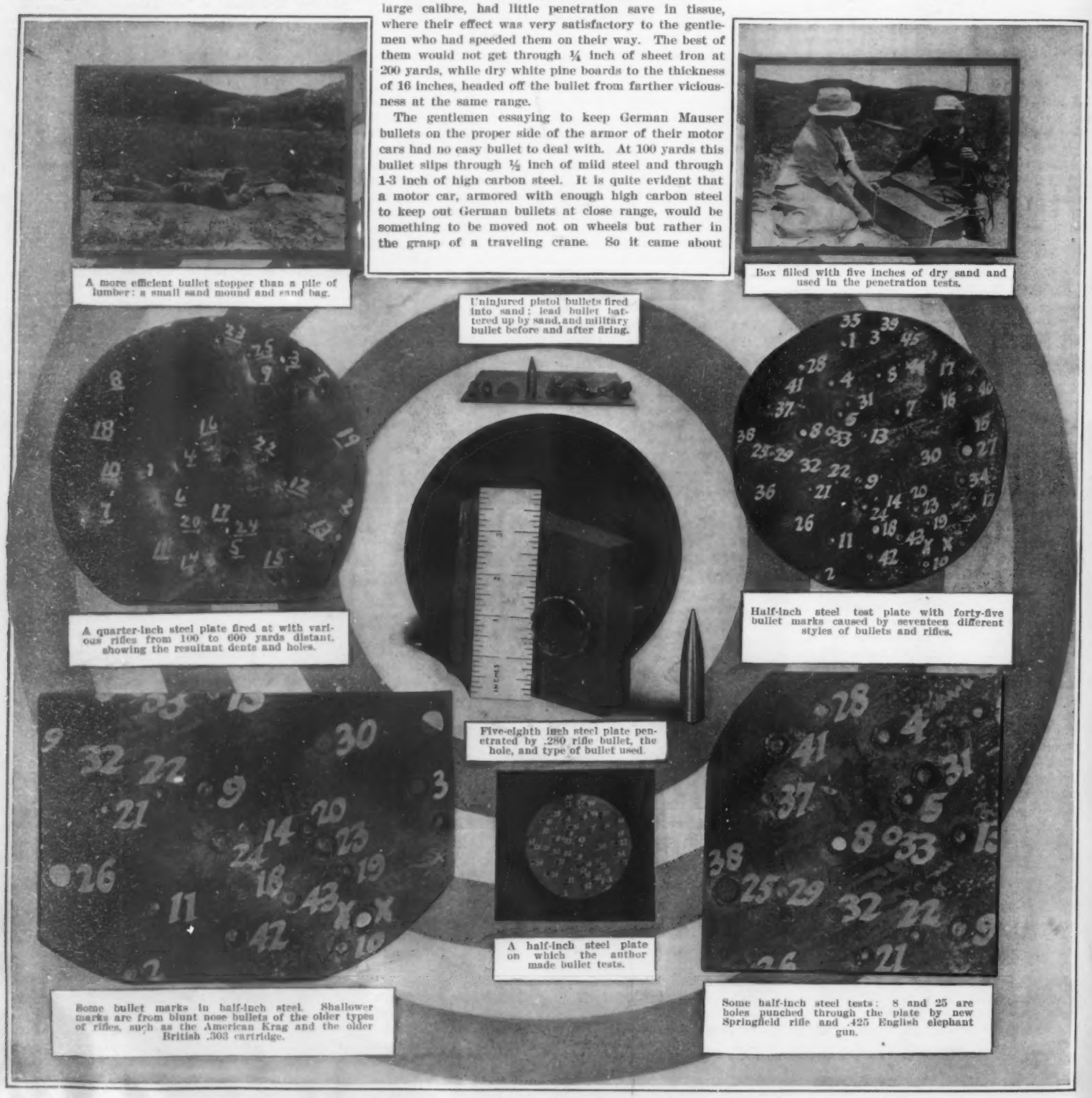
The gentlemen essaying to keep German Mauser bullets on the proper side of the armor of their motor cars had no easy bullet to deal with. At 100 yards this bullet slips through ½ inch of mild steel and through 1-3 inch of high carbon steel. It is quite evident that a motor car, armored with enough high carbon steel to keep out German bullets at close range, would be something to be moved not on wheels but rather in the grasp of a traveling crane. So it came about that the British steel makers, since the outbreak of war, found a sudden and lively interest in the development of a steel that was stubborn in the matter of letting bullets go through.

Various alloys were tried, with diverse stages of heat-treatment. Also was considered the matter of angles at which bullets might impinge upon the armor. Obviously, to make the sides of the car protection flat was to encourage the presence of undesirable missiles within the car. So came about the arrangement of the armor in such a manner that striking bullets would glance off as far as possible, or else would have more steel to go through because of the indirect travel.

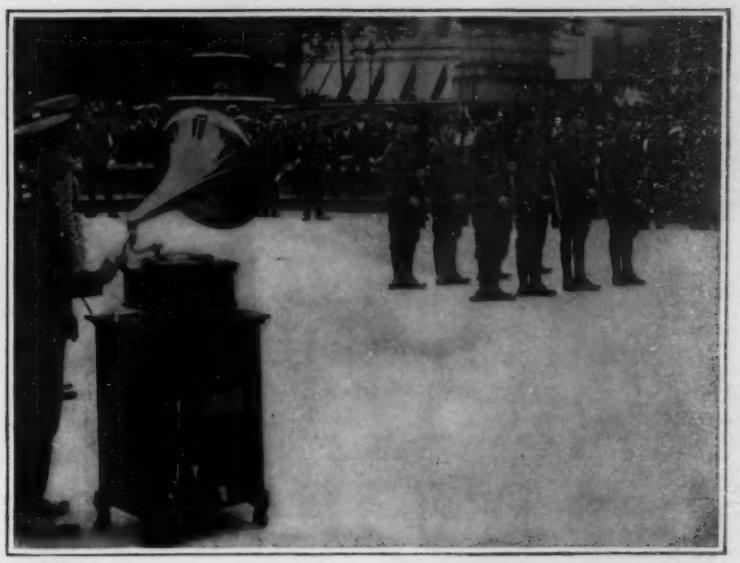
Trials of armored cars in the Mexican argument demonstrated a hitherto unthought of danger from bullets striking below the cars, just short of the wheels, and then ricochetting up through the floor, to the discomfiture of its inmates or the wrecking of the machinery. This, too, had to be taken care of.

At present, armored cars use steel of around 1-5th

(*Concluded on page* 411)



Various examples of the penetration of bullets in dry sand and in steel plates



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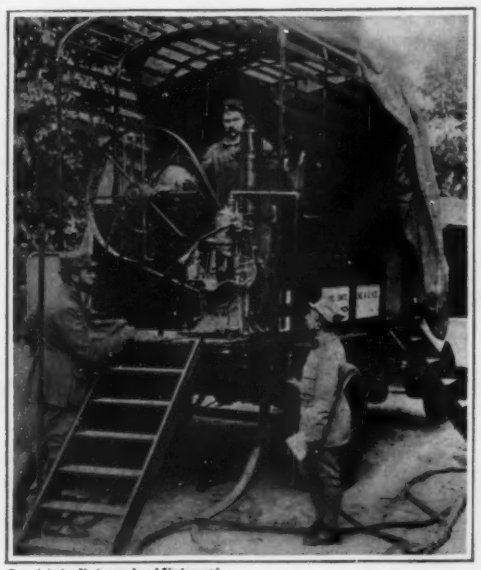
Using a phonograph in London to make an appeal for recruits and to give the commands at a display drill



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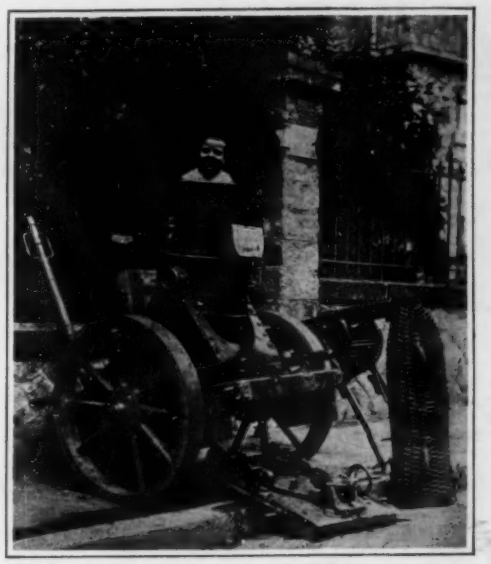
French army ice machine mounted on a motor car



Medem Photo Service

German mortar captured in the Vosges

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French artillerymen protected against poison gases

Medem Photo Service

French anti-aeroplane machine gun mounted on a cartwheel and barrel

Copyright by Underwood and Underwood

German motor train captured in South West Africa

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Removing a severely wounded British air scout from his machine

Medem Photo Service

Italians cutting barbed wire entanglements near an enemy trench

With the Camera in Warring Lands

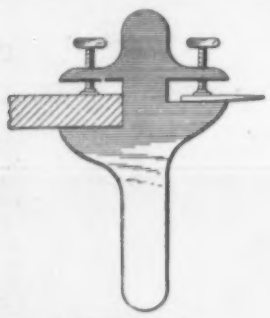
RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Pertaining to Apparel

BUST REDUCER BRASSIÈRE.—MARIE PERILLAT, 15 W. 38th St., New York, N. Y. This invention provides a device having a neat appearance which serves to reduce or support a woman's bust in accordance with the demands of the present modes of dress. It provides a device for use by large women which will serve to add to the graceful appearance of their busts as well as adding to their comfort.

SKIRT MARKER.—CORA B. LEMON, Grants Pass, Ore. This invention has reference to dress-making, particularly to the accurate arrangement of the bottom of skirts, and is of especial value to women making or fitting their

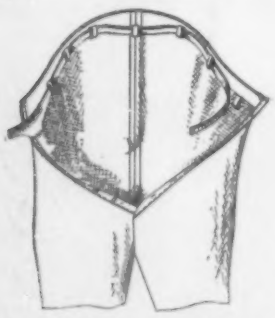


SKIRT MARKER.

own skirts, and the main object thereof is the provision of a device whereby a person may positively adjust the bottom of the skirt into absolute parallelism with the floor unaided.

COLLAR BUTTON.—R. N. SAUNDERS, Deputy County Clerk, Hudson, N. Y. The button is for application to the front of a shirt band to facilitate the buttoning of a collar by providing an extension of the collar button which lengthens the latter temporarily and permits the operator to have something to grasp with one hand to hold the button in place, while the other is free to slide the collar or other clothing to be closed, over the head of the button, said extension being afterward hidden from view.

BELT ATTACHMENT FOR TROUSERS.—W. D. WOODRUFF, Belton, Tex. This invention is an improvement in belt attachments for trousers in which the latter are provided with belt loops inside the waistband, the loop in the



BELT ATTACHMENT FOR TROUSERS.

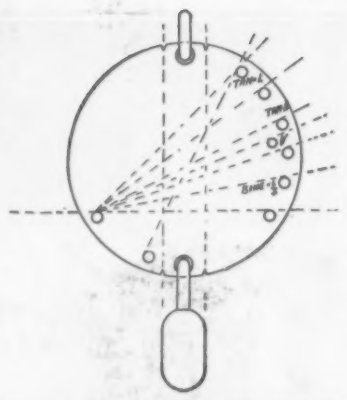
middle of the back being located lower than the others, and a belt confined entirely within the trousers and secured to the trousers at the front only and at a point lower than the adjacent loops.

TOE OR HEEL PLATE FOR SHOES.—G. C. MEAKIM, Borden Ave., Laurel Hill, L. I., N. Y. The invention has particular reference to anti-slipping devices for shoes. It provides a toe or heel plate to be secured firmly to the bottom of the sole or heel of a baseball shoe or other shoe and to be used as a substitute for the common steel toe and heel plates.

UNDERGARMENT.—LAURA I. COLLETT, 1635 Hardesty Ave., Kansas City, Mo. This invention relates to wearing apparel and the object is to provide a woman's knit undershirt or vest arranged to snugly fit the body and to be firmly held in place without the use of undesirable and unsightly shoulder straps or sleeves.

Of General Interest

APPLIANCE FOR MEASURING AND COMPUTING HEIGHTS AND DISTANCES.—R. R. MILLER, 1324 Fitchland Ave., Toledo, Ohio. The construction of the appliance is rugged, portable, not easily put out of adjustment, but easily understood, and gives results sufficiently accurate for the use of woodsmen, sportsmen, wiremen, prospectors and others who wish an approximate measure of the heights of trees, wires, projections, hills and the horizontal distance to a point directly below some point on



APPLIANCE FOR MEASURING AND COMPUTING HEIGHTS AND DISTANCES.

the hillside and similar measurements which cannot readily be made by direct measurement with a tape line or other ordinary method unless regular surveying instruments are resorted to.

SPRING AND PRESSER BAR FOR FOUNTAIN PENS.—E. F. BRITTEN, JR., care of L. E. Waterman Co., 173 Broadway, New York, N. Y. This invention has reference to fountain pens of that type in which the writing fluid is contained in a sack in a barrel of the pen, and the invention has to deal more particularly with the sack presser bar and return spring therefor.

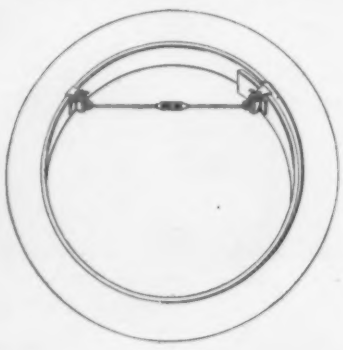
TOBACCO POUCH.—W. H. STROMEYER, 1008 Trinity Ave., Bronx, N. Y., N. Y. The pouch securely holds the tobacco and superimposed sheets of cigarette paper, and allows the user to readily discharge the tobacco in stream form and in any quantity from the pouch into a sheet of cigarette paper without spilling the tobacco, at the same time facilitating the distribution of the tobacco on the paper preparatory to the final production of the cigarette.

Hardware and Tools

WELL CASING SPEAR.—W. Y. JACK, 618 Lexington Ave., New York, N. Y. The spear consists of a plurality of dogs which are automatically retracted during the lowering of the tool into the well pipe and which automatically expand and grip the pipe as the tool is raised, whereby the greater the resistance of the casing's removal the greater is the grip of the dogs on the casing, so that slipping is prevented.

HAND BAG LOCK.—M. BROOKS and H. B. FREEMAN, 473 Broome St., New York, N. Y. The invention relates to locking means for bags, and has reference more particularly to a lock for hand bags. The object is to provide a lock which is simple in construction and which will positively lock the bag so that the same can under no circumstances accidentally unlock itself.

RIM TOOL.—M. M. HERMAN, 301 Herman Bldg., Danville, Va. The present invention relates generally to tools for reducing the normal circumference of split demountable rims of various types, and more particularly to the tool in Mr. Herman's Patent Number 1,113,139. The present invention provides a tool including



RIM TOOL.

clamping members, having engagement with portions of the inner periphery of a rim as well as the side edges thereof, without necessitating particular formation of the rim, and permitting the tool to be utilized in connection with any rim of the demountable type.

WRENCH.—L. W. MILLSAP, JR., 426 1st St., Woodland, Cal. The wrench comprises a movable jaw and a fixed jaw, wherein the coarse adjustment is obtained by means of a screw or worm, and wherein the fine adjustment is obtained by the direct movement of the jaws toward each other, to permit the jaws to grasp an object of any size between the extreme open and extreme closed position of the jaws.

HOSE RACK.—O. D. MOCK, care of Brinton B. Davis, 1909 Inter Southern Bldg., Louisville, Ky. The improvement refers to water distribution and has particular reference to hose racks such as are adapted for use in connection with office buildings or other analogous structures for supporting fire hose in position to be easily accessible in case of emergency.

Machines and Mechanical Devices

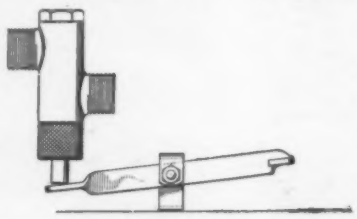
MACHINE FOR TREATING MATERIALS WITH A LIQUID.—FRANZ SCHUBERT, 63 Hammerlandstrasse, Hamburg, Germany. This invention relates to a machine which can be used to treat specifically light raw materials as well as half and entirely finished articles, especially those produced by the textile industry, with a liquid either for softening, cleaning, washing, impregnating, bleaching or dyeing purposes. It is especially suitable for soaking, washing and cleansing linen articles of clothing and the like, and can also be employed for purifying or cleansing cellulose, cereals, coffee-beans, etc.

POWER SPUD FOR DREDGES.—LOUIS HALLUM, Aitkin, Minn. The object of the invention is to provide a new and improved power spud for dredges and similar machines, arranged to permit of conveniently and quickly adjusting the spud, to change the position of the dredge or similar machine correspondingly, whenever it is desired to move the machine from one place to another.

SIMPLEX ROD SLIP.—J. B. DUNLAP, 618 N. Boston Ave., Tulsa, Okla. The invention is an improvement in simplex rod slips and has for its object to provide a device adapted for lowering a sucker rod into a well casing wherein a stand is provided having means for clamping the upper end of the well casing; the stand being provided with a plurality of mechanisms for clamping the rods alternately or together.

SAWING MACHINE.—G. J. TAPPAN, Tulalip, Wash. This machine may be employed for a great variety of purposes but it is particularly well adapted for cutting out portions of floors and for cutting through siding and sheeting of a building when it is desired to cut an opening or build on an addition.

FLUID PRESSURE CONTROLLING VALVE.—JOSEPH BRUNKER and CHARLEY A. MATTMILLER, 1430 Lyndale Ave., Helena, Mont. This invention is an improvement in fluid pressure controlling valves and has for its object to



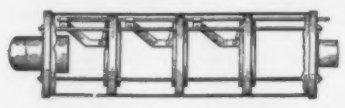
FLUID PRESSURE CONTROLLING VALVE.

provide a valve especially adapted for use with locomotives or electric motors for controlling the operation of the compressed air used in braking, sanding or bell-ringing, wherein mechanism is provided adapted to be operated by a pedal or any other suitable manner for admitting the full pressure of the air instantaneously or to its full extent with a very slight movement.

Prime Movers and Their Accessories

GREASE CUP.—T. O. ORGAN, 21st and Clearfield Sts., Philadelphia, Pa. In carrying out the invention the piston is formed in two members separately movable so that one may move relatively to the other. The one member is in the grease-tight contact with the wall of the cup, while the other is in grease-tight contact with the feed tube, the two members being in contact with each other.

MUFFLER.—C. A. MILLER, Spring Valley, Ill. The invention relates more particularly to a muffler adapted for use in connection with combustion engines. It provides a plurality of baffle plates arranged in the casing of the muffler whereby the force of the exhaust gases



MUFFLER.

is retarded and the noise occasioned thereby reduced to a minimum. It also provides means whereby the baffle plates may be adjusted in order that the same may be cleansed by the force of the exhaust passing through the cylinder.

INTERNAL COMBUSTION ENGINE.—F. D. CALKINS and A. C. JOHNSON, Sunnyvale, Cal. The object here is to provide simple and inexpensive means for controlling the admission and exhaust of the motive fluid, wherein a continuously rotating valve having a large bearing surface is provided, separated from the explosion chamber, and arranged to automatically compensate for wear.

CARBURETER.—T. O. WINGER, R. 2, Amery, Wis. Prime objects of the invention are to provide a device whereby effective contact with the gasoline will be brought about, and to provide a device having provision for adjustment to vary the contract surface between the air and gasoline or the period of contact whereby to vary the character of the mixture as to its richness.

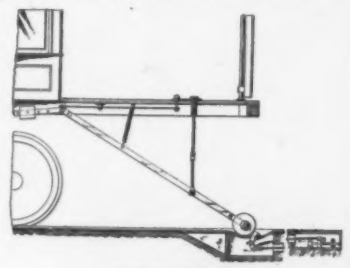
Railways and Their Accessories

AUTOMATIC RAILWAY SWITCH DEVICE.—R. I. PARTIDA, 501 Zaragoza, Laredo, Tex. An object of the invention is to provide a member for moving in a guideway on a car, the member having a pivoted arm for engaging the trip member when moved with the car in one direction, the arm being free to move in the said direction relatively to the member and the car, when the car is moved in the opposite direction.

ADJUSTABLE TRACK GAGE.—W. H. DAVIS, Room 2602, 165 Broadway, New York, N. Y. An object here is to provide a track gage which is formed with an adjustable part for allowing the gage to be shortened or lengthened as occasion may demand, this construction being such as to present an adjustable feature without weakening the general structure of the gage.

AIR BRAKE DEVICE.—E. U. MACK, 327 E. Palmetto St., Florence, S. C. This invention provides means under control of the engineer for retaining the air pressure in the brake cylinders of the cars of the train while the auxiliary reservoirs thereunder are being recharged, thereby securing greater safety in handling trains on grades, and also securing greater economy in the use of air and dispensing with the services of the train hands or brakemen for the purpose.

SWITCH SHIFTER.—AMBROSE MCVEY, N. W. Corner 7th and Grand Sts., Wilmington, Del. This invention relates to means for switching street railway cars and the main object is to provide a device which will accom-

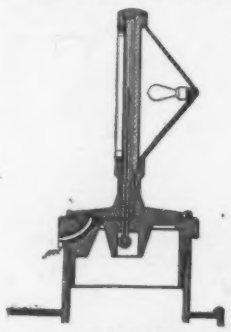


SWITCH SHIFTER.

plish this result from the front platform of a car and be under control of the motorman. Another object of the invention is to provide a device which is normally out of operative position, but which may be placed in operative position by the motorman's foot. A further object is to provide a foot pedal whereby the motorman may, at will, throw a switch to the right or to the left.

Pertaining to Vehicles

RADIATOR THERMOMETER CAP.—DONNELLY P. FRASER, 937 Park Ave., Brooklyn, N. Y. The primary object of this invention is



RADIATOR THERMOMETER CAP.

to provide a cap for a standard radiator neck, fitted with a thermometer, an electric lamp to render the readings of the thermometer visible at night or in dark places and electric terminals for supplying current to the lamp. A further object is to provide a cap with fixed and movable sections; the former being arranged to be fitted as a practically permanent part of the neck, while the movable section is for refilling the radiator. The movable section may be removed without attention to the electrical connections. Another object of the invention is to provide a thermometer cap, the bulb of which is contained within a pocket in one of the cap parts, thus protecting it from direct contact with the heated water.

PNEUMATIC WHEEL.—J. DOVE-SMITH, Niagara Falls, New York. This invention has reference to resilient wheels and has particular reference to wheels of this character which are intended to afford a cushioned support for vehicles or the like but without the attendant dangers or annoyances incident to wheels having tires made of rubber or rubber composition.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

The Effect of Acetylene on Metals

THE nature and amount of the action in various metals is one of considerable technical importance. A careful study of such action has been recently made by Mr. H. Reckleben and Mr. G. Scheiber, and is reported in the *Chemiker Zeitung*. Acetylene produced in the ordinary way was allowed to act for a period of twenty months at ordinary pressure and temperature on a great variety of metals. Furthermore, three series of experiments were instituted. In the first, crude acetylene was conducted over the metals to be tested. In the second series the gas was previously purified, and in a third series it was also dried.

The following metals and alloys were tested: zinc, twenty months at ordinary pressure and temperature on a great variety of metals. Furthermore, three series of experiments were instituted. In the first, crude ium-bronze, phosphorus-bronze, and finally type-metal and soft solder. The last eight were in the form of shavings.

The results of the action were as follows: Pure dry acetylene had no effect on any of the metals tested; pure but moist acetylene caused no alteration in the appearance of any of the metals, but merely occasioned a slight increase of weight in copper and nickel; finally the gas, when both moist and impure, caused scarcely any alteration in tin, red-brass, palladium, aluminium-bronze, type-metal and soft solder; but zinc, lead, brass and nickel gained somewhat less than 1 per cent in weight, while iron, art-bronze and phosphor-bronze showed a gain in weight of 6.4 per cent or 6 per cent (*sic.*) to 14.4 per cent, and also lost their metallic glitter and became black. But copper was the metal which was altered most and with the greatest rapidity; it not only gained heavily in weight, but became partially covered with a black crust. However, a minute examination showed that there was no formation of acetylene-copper, since the substance formed could not be exploded either by heat or by percussion. When the copper was treated with acid no acetylene was evolved, but traces of sulphureter hydrogen were perceived, and there remained a black "humoid" substance.

The same result was obtained when a copper tube was employed to conduct acetylene. The tube became stopped up while in use. The black powder which was scraped out of it had no explosive properties. It contained no calcium compounds, but was rich in carbon (Kohlenstoff).

Because of the above results, the authors advise the use of copper and its alloys in the installation of acetylene plants, since this precludes the danger of explosion. To avoid this they recommend plating with nickel or tin.

Delusions About Underground Water

MR. R. E. HORTON, the well-known hydraulic engineer, has published an interesting *memoir* entitled "Idiosyncrasies of Underground Water," in which he calls attention to a number of widespread popular delusions on this subject. One common belief is that all ground waters occur in cracks, crevices or fissures of the earth, and in every countryside one hears of wells reputed to be inexhaustible because fed from an "underground river." Again, "there is scarcely a town or county in the country which is not reputed to have one or more lakes or ponds without bottom. The explanation is simple in most cases. This belief results: First, from the difficulty of making accurate soundings in very deep water with moderate weights and ordinary lines, owing to friction; second, from the difficulty of determining when the bottom is reached in lakes or ponds having soft or mucky beds." Another popular assumption is that artesian wells are necessarily very deep. Though they are, of course, much deeper on the average than wells in the surface zone of ground water, wells yielding strong artesian flows are occasionally quite shallow. Such wells having depths of 20 to 50 feet are common in the glacial deposits of Michigan, and quite a number in the same region are not deeper than 12 or 15 feet. Last, but not least, springs generally have an undeserved reputation for constancy and purity. The majority of springs are of local origin, are inconstant in value, often of uncertain quality and of small yield.

Imitation Fur or Velvet

A PROCESS patented in France consists in an improvement in the manufacture of stuffs or objects which imitate fur, plush or velvet, or for use as carpets and the like. The process starts with an animal's fur, or an assemblage of animal or vegetable fibers, and these are immobilized by freezing them in a block of ice. The ice is then sawed into slabs, and a slab is made to undergo a surface melting so as to partially free the hair or fibers on one side; then a suitable glue or cement is applied upon this surface. A sheet of flexible material acting as the basis of the new makeup is then laid on, so that the hairs adhere to it, and afterward the whole is freed from the ice by melting, leaving the hairs attached to the support. Rubber serves as a good basis for the glue or cement, and the support is also coated with the same, and this rubber can then be vulcanized so as to give good adhesion and suppleness.

Snow in South Africa

DURING the past (southern) winter the people of Kimberley, South Africa, enjoyed the unusual experience of a snowstorm. A correspondent of *Symons' Meteorological Magazine* writes that "people all turned out to snowball, and the natives, many of whom had never seen such a sight before, were most excited. My native charwoman told me when she woke in the morning that she thought some one had been breaking into the shops and had scattered flour all over the place!"

Spendthrift Artillery

LIEUT.-COL. BOISSONET explains in the Paris *Temps* some of the many reasons which make spendthrift artillery one of the necessary factors of victory.

The *Army and Navy Journal* translates the *Temps* article as follows:

The French "75" is a weapon of marvelous precision, but, even with a new gun and the shells in perfect condition, after a great number of shots from a distance of 3,000 meters the shells will be found to have fallen within a radius of ninety-six meters, and half the shells will have fallen in a strip of about twenty-four meters. The gunner, therefore, has to regulate his fire so that the object aimed at will be in the center of this most thickly covered strip, a task which against trenches, even after aeroplane reconnaissance, requires a considerable expenditure of ammunition; and when it is remembered that the trench itself is not much more than a yard or so wide, it will be realized that for every three or four shells which burst in the trench, a vast number explode before it or behind it.

The need for heavy shell expenditure against trenches is already great, but it will become more urgent still after the siege period is over and real field fighting again becomes possible, when the artillery will have not the fixed target of the trench line, but the thin *mobile* ranks of the skirmishers, as its objective.

Against moving infantry, unless it is advancing in close formation, regulated fire is a matter of some difficulty. Infantry which finds itself between the first shell which has burst behind them and the short shell which has burst in front of them do not await the avalanche which is to follow, but rush rapidly forward beyond the first short shell, where they fling themselves to the ground under what cover they can find. The artillery knows that they are somewhere in the neighborhood, and to begin again the *tir de réglage* would only be a loss of time, so that the only thing for the artillery to do is to shorten its range by 100 yards or so and sweep the whole of the zone where they imagine the enemy's infantry to be with shrapnel.

A battery of 75-millimeter guns fires no less than eighty shells a minute, and it is only with rapid, intense fire that the shrapnel fragments can sweep a whole

countryside and break the enemy's attack. The same thing applies when the artillery is taking part in an offensive. They have to cover the whole zone of the enemy's front with a shower of shells, forcing the gunners to take shelter and pinning the infantry to the ground while their own troops are advancing.

The Dyestuff Famine.—I

(*Continued from page 400*)

the production of an equivalent amount of toluol. Unfortunately, the demand for both benzol and toluol, to be used in the manufacture of explosives, is now so abnormally high that there has been some difficulty in securing enough for the makers of coal-tar intermediates. The manufacture of these latter, especially of aniline, has suddenly grown to considerable proportions, and is constantly increasing. There are a dozen firms engaged in this branch, and others are entering the field. There are seven firms now busily engaged in making finished coal-tar dyestuffs. As stated, the output is double what it was in July, 1914. It will soon be trebled.

In this connection it must not be forgotten that aniline, itself, when destined for use in dyeing aniline black, should be classed as a finished dyestuff. A large share of the aniline now being produced, is used for this purpose, especially in hosiery mills. When we think that a single firm, such as the Edison Company, is turning out 6,000 pounds of aniline each day, we begin to grasp what is being done to lay the foundations for a comprehensive American dyestuff industry.

Verbally and in print, I have emphasized the eminent desirability of increasing the output of aniline, rather than to branch off into the manufacture of a varied list of dyes. Ambitious young chemists are keenly desirous of bringing out at once finished dyestuffs, in a greater or less variety. As a rule, they now recognize that they can best serve the textile and other industries dependent upon colors, by concentrating their efforts on aniline. The logic of the situation plainly shows that in no other way can they make plant, time and effort count as effectively in lessening the hardships of the current famine. Four-fifths of our hosiery are dyed black, and the extent to which black is used for both men's and women's apparel is evident to all.

An interesting feature in the evolution of this aniline industry—in the narrower sense of the term—is the introduction of small plants for making the oil, devised more particularly for installation in textile works, consuming relatively limited amounts, in the production of aniline black. An enterprising Rhode Island firm, manufacturing itself considerable quantities of the oil, is now installing in various textile mills standard plants capable of producing daily 100 pounds or more of aniline. Such a plant, built to produce 100 pounds daily, costs from $1,500 to $2,000. The services of a single operative are needed to carry on the transformation of benzol into aniline, with occasional assistance in the moving of heavy objects. The operations, and the application of the requisite tests, can be intrusted to a man of ordinary intelligence, without chemical education. The ordinary output is 85 pounds of aniline for each 100 pounds of benzol employed. At current rates for this hydrocarbon it is found possible to make aniline at a net cost of from 30 to 40 cents per pound. This compares favorably with the daily quotations of $1.30 for immediate delivery, and of $0.70 to $0.85 for early contract delivery. Within the past few days, two textile mills have contracted for larger plants, capable of furnishing 500 pounds of aniline daily.

The extensive works of the Benzol Products Company, at Marcus Hook, Pa., has received notable additions. It is now the leading source of supply. This company, organized in 1910, was the first to manufacture aniline on a large scale in this country.

The policy of the seven companies engaged in the direct manufacture of finished dyestuffs has been eminently a wise one. They have resolutely contracted the range of dyes which they attempt to put on the market. There has been a corresponding increase in the quantity of actual dyes manufactured in a given period.

It is evident to all that under existing circumstances every possible effort is to be directed toward enlarging the volume of the output, and this can be secured only by severely limiting the number of different dyes produced, and by corresponding simplification in organization and plant. How easily this can be done, without involving any serious hardships to consumers of dyestuffs, can be illustrated from the practice in the silk branch.

Ordinarily, silk dyers in the vicinity of New York are accustomed to carry a very large variety of colors. The other day I asked one of the leading dyers in the neighborhood to make out a list of what dyes were absolutely necessary. For purposes of comparison, I asked him to add, also, the quantities of each color required during the year. This he did. The following is the list:

Colors Needed in Silk Dyeing

Yellow

Auramine, 1,200 pounds.
Azoyellow, 14,000 pounds.
Chinoline Yellow, 1,200 pounds.
Chrysoidine, 3,600 pounds.
Chrysophonine, 1,000 pounds.
Orange, 3,000 pounds.

Green

Brilliant Green, 1,000 pounds.
Direct Green, 1,000 pounds.

Red

Alizarine Claret, 1,500 pounds.
Fast Red, 7,000 pounds.
Rhodamine B, 2,000 pounds.
Alizarine Red 8X, 2,500 pounds.

Purple

Hofmann's Violet N, 600 pounds.
Methyl Violet, 5B, 1,000 pounds.
Fast Acid Violet 10B, 5,000 pounds.

Grey and Black

Induline, 2,500 pounds.
Developed Black, 10,000 pounds.
Sulphur Black, 15,000 pounds.
Direct Black, 1,000 pounds.

Blue

Alkali Blue 2B, 4,000 pounds.
Charge Blue OB, 2,500 pounds.
Methylene Blue, 10,000 pounds.
Patent Blue, 1,000 pounds.
Victoria Blue B, 12,000 pounds.
Sky Blue, 1,000 pounds.

He added that the following colors were very helpful:

Yellow

Direct Yellow, 1,000 pounds.

Blue

Pure Blue, 1,000 pounds.

Red

Fraise, 1,200 pounds.
Direct Red, 1,000 pounds.

Green

Malachite Green, 800 pounds.
Wool Green S, 1,500 pounds.

Purple

Brilliant Violet 6B, 1,000 pounds.
Various Alizarine, Algol, Ciba, Helindon, and Indanthrene colors.

As is seen, the actual needs of a leading silk dyer narrow down to 25 different colors. With an adequate supply of these 25, he claimed that his business would suffer no material hardship.

Similar statements, regarding the variety of dyes needed, would probably hold good in cotton and woolen branches.

It is a welcome fact in this connection that two well-equipped works are now about to manufacture sulphur black on a large scale. Two other works engaged in the production of intermediates have perfected their arrangements to make ample supplies of the dinitrochlorbenzol required in this special branch.

The most interesting feature to note in this development is the establishment recently on our soil of the commercial production of synthetic indigo. This manufacture has been taken up by one of the older chemical companies and with success. The output will be steadily increased. Naturally all that can be made is sold for a year ahead. Three other powerful firms are carefully studying the possibilities of manufacturing this most important dyestuff.

When one reflects that the great "Badische" company on the Rhine expended $5,000,000 on its indigo plant and on the necessary research, before a single pound was placed upon the market; and when we further consider that indigo is upon our free list, we can but admire the pluck and enterprise of our fellow citizens as manifested in this field.

Extended Use of Natural Dyes

While the output of artificial dyes of domestic origin is thus increasing at a

rapid rate, it is necessarily far removed from meeting even a quarter of the national demand under normal conditions. Here, the existing equipment in half a dozen large American works, organized for the production on a large scale of natural dyes, has proved to be a national asset of pronounced value.

The method for using natural dyestuffs such as logwood, fustic, cutch, etc., have been notably perfected of late. In nearly all branches of the textile manufacture it has been found practicable to introduce their use. The current output of dyewood extracts is now about three times as great as it was before the war, and it is constantly increasing. Logwood blue is now in widespread use, instead of indigo, for dyeing denims and similar fabrics.

The silk industry is already accustomed to the use of large amounts of logwood. Dyers of silk fabrics are now attentively studying the availability of other dyewood extracts under existing circumstances. A welcome addition to the domestic supply of natural dyestuffs is the handsome yellow, obtained from the osage orange of the Mississippi Valley. The dye is the same as that present in fustic. It is, however, a pure compound, free from the varying admixture of a reddish coloring matter, which renders the use of tropical fustic somewhat uncertain.

Cooperation of Manufacturers and Consumers

Even with the aid of a vastly increased employment of natural dyestuffs, we are far removed from meeting even the half of our customary requirements of organic colors. It has become evident that a serious dislocation in the whole organized system of retailing and using textile fabrics, involving the factor of color, can be avoided only by a genuine spirit of sympathy and cooperation between the two final links in the chain joining the producers of raw material and the consumers of finished products.

Manufacturers, for example, are practising a most rigid economy in the use of color compounds. This is exemplified in the use of pencil lines for heavy stripes, in the substitution of outline designs for conventional patterns requiring extravagant quantities of color, and in analogous directions. There is also a pronounced tendency to urge the wearing of white articles of apparel.

In order, however, to limit to the utmost the hardships incident to such a pronounced shortage of dyes, the conditions must be met in a brave and common-sense manner. Unless the American public is willing to see our textile interests thrown completely out of gear, there must be a most pronounced spirit of compromise and adaptation on the part of the ultimate consumer. Whims, fancies, fads, habitudes of the past, rivalries of the future, all must disappear before actual conditions.

Consumers must recognize and accept these existing conditions in a considerate manner, adjusting themselves to limitations in variety of shade, as well as in fastness. This will take a vast burden of anxiety from the shoulders of tailors, milliners, and dressmakers. They, in turn, can make more easily their contract with the retailer. He can deal with greater certainty and assurance with the jobber. The relations of the latter with the manufacturer will be vastly simplified, and he can with increased confidence order supplies to be handled six months or a year hence. It is a long chain. A spirit of generous compromise on the part of the ultimate consumer will give to it the needed strength. A finical, critical, fault-finding attitude, will, on the contrary, cause the chain to snap and break.

(To be continued.)

Nationalization of the National Guard

(Continued from page 395)

quate citizen soldiery. When questioned they invariably point to the frequent lack of discipline in the Guard as compared with the regular army. The disposition to compare the Guard with the regular army is in itself distinctly unjust, because of the wholly different conditions that obtain in the two branches of the army.

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It is not only almost wholly impossible to obtain the same standard of discipline in the guard as in the army, but it is not absolutely necessary. In the army (the regular army if you please, for the Guard is part of the army) the company commander has his recruits not only enlisted for him, but they are delivered to him fully equipped and partly drilled. In the Guard, a company commander has not only to obtain his own recruits, but has to secure them in most cases against the opposition of the employer who doesn't want to let his men off for the summer training camps, or for an occasional day on the rifle range, and against the local mandate of many trade unions that are antagonistic to the Guard, because the organization is subject to strike duty, or in the face of that most serious obstacle of all, the more or less scornful attitude assumed by many of our so-called good citizens.

As a company commander, I have had to contend with each of these obstacles, and know that they exist not only as isolated cases, but are prevalent to a large extent throughout the whole country, and their harmful influence cannot be overestimated.

It is manifestly impossible for a company commander of the National Guard to maintain the high standard of discipline obtained in the regular army, when he has to persuade men to join his company in the face of the difficulties imposed by such conditions. In addition to these difficulties, the niggardly appropriations made by most states make it necessary for these officers personally to defray the many little items of expense, incident to maintaining a reasonably efficient organization.

Inasmuch as no encouragement is received by the recruit from his employer or his fellow citizens, and he receives no drill pay for his service, some inducement must be made to induce him to enlist, in addition to the patriotic impulse that most of our young men normally possess. In some states, in the large cities, adequate armories with club and athletic features are provided; but in most cities these features are lacking and it devolves upon the company commanders to provide them.

No matter what legislation is passed by Congress, whether it be a reorganization of the present Guard or a wholly new scheme, we shall never succeed in creating an adequate volunteer citizen soldiery until we have first created a condition that will make service in that body popular. When the average young American learns to feel toward the Guard as he does toward his Alma Mater, and toward his fellow Guardsmen as he does the fellow members of his "Frat," we will have a citizen soldiery that will not only be efficient, but one of which we may justly feel proud.

I once asked a young Englishman if he had had any military training. With visible pride he replied—"Yes, in the King's Own." When we establish and maintain a Navy reasonable in size and properly balanced and efficient as our Navy men know how to make it; when we have created a modest but well equipped Regular Army, with a Reserve into which to graduate our trained men, and when we have created a mental attitude toward service in our Citizen soldiery that will enable our young men to say with pride that they have served in "Uncle Sam's Own," we will have solved the problem of National Defense.

These United States do not belong to the present generation; they did not belong to the last, nor will they belong to the next. Our country and all it stands for constitute a sacred trust, with each succeeding generation as trustees. We are obligated by the highest sense of duty to safeguard those institutions against every possible danger.

It is not sufficient to say that there is at present no evident danger of aggression from this or that Nation. We must as trustees guard our trust not only against every probable danger, but every possible danger as well, or else we are derelict in our sacred duty.

The present deplorable condition of our National Defenses is very properly a matter of grave concern to every true American citizen.

The National Security League is a patriotic, non-partisan and non-military organization, endeavoring to crystallize latent public sentiment in favor of a proper National Defense into the action needed to impel Congress to pass the Legislation necessary for this purpose.

While it is the duty of the League to defer technical matters to the judgment of our expert military boards, the General staff of the army and the General staff of the Navy, there can be no question that an adequate National Guard is of vital importance to a comprehensive plan of defense. This cannot be obtained without more cooperation on the part of the employers of the men who enlist in that organization. As a means of bringing this about, the National Security League has not only placed the matter before the large National corporations, as referred to in General Logan's letter, but has appealed to over fifteen thousand firms throughout the country, asking them also to do their part in this cause.

Three Thousand-Volt Direct-Current Electric Locomotive

(*Concluded from page 393.*)

controls the train by reversing the current, which changes the motors into generators and sends back into the line about 30 per cent of the energy used in hauling a train up grade. This results in a uniform speed on all down grades and makes it unnecessary to resort to the air brakes except in cases of emergency. Not only is the train more uniformly controlled by this method, but all danger from worn brake-shoes or overheated wheels is eliminated, not to mention the direct economy effected.

The electric locomotives operate at their best efficiency in the coldest weather—quite the opposite to steam locomotives, with which trouble is experienced in maintaining the steam under like conditions. They require inspection only once in every 2,000 miles of travel, whereas the steam locomotives must be overhauled at the end of each division, or after every run of 100 or 125 miles. Another advantage in favor of the electric locomotive over its steam competitor is that the latter consumes 80 per cent of the fuel used in actual service while standing at division points, while the electric locomotive consumes power only when in motion.

The passenger locomotives on the new electrified line are geared to haul 800 tons at 60 miles an hour, while the freight locomotives will haul 2,500 tons on a one per cent grade at a speed of 16 miles per hour. When two locomotives are used to haul a train, about the same speeds can be maintained on a two per cent grade.

Owing to the greater speed of the electric locomotives over the huge Mallet steam engines which they are replacing, it is believed by the railroad company that the same results will be achieved as though the line had been double tracked over the mountain division. Present plans of operation call for the general use of an electric locomotive at each end of a train on up grades approximately 35 miles long over the electrified section of the road, while on down grades only the head engine will do the regenerative braking.

Penetration of Bullets

(*Continued from page 404*)

inch thickness, but toughened by the addition of vanadium, etc., and heat treated into the bargain. There is a huge difference in the ability of steels to resist bullet penetration.

The field guns and siege guns of the American service are provided with steel bullet shields, hardly ¼ inch thick, but very hard and tough. Each one of these on completion is tested by having two or three shots actually fired at it from an army rifle at close range. Ordinary mild steel, boiler plate, etc., show the following effects from various bullets.

A plate a full half inch thick, and with a tensile strength of 65,000 pounds per square inch, is penetrated at the muzzle

by the German Mauser, the Turkish Mauser, the Austrian Mannlicher, and other military rifles of like ballistics. The American New Springfield gets nearly through with its 150 gr. bullet, and through with the 180 gr. bullet used for target shooting. The little 85 grain .25 cal. Savage bullet gets as nearly through as the bullet from the American service rifle. The .280 Canadian Ross rifle shoots through the half inch, and has gone through ⅝ inch of good steel.

On a plate of ¼ inch mild steel the three foreign service rifles, mentioned in the foregoing paragraph, register complete penetration at 500 yards. The American rifle gets through with 180 gr. bullet. The Ross gets through with 140 gr. copper capped hunting bullet. The Japanese service rifle shows superior penetration to those mentioned, because of its smaller calibre, .25 against .30-inch.

In wood, the .280 calibre Canadian Ross rifle shows the greatest penetration, nearly 80 inches of dry pine—almost seven feet. The American rifle shows a more striking variance between the 50 feet—practically muzzle—range and the 100-yard range in oak than it does in pine. At 50 feet it gets through 12 inches of seasoned oak, at 100 yards through 33 inches.

The theory is that this failure to show so much penetration at close range is because the bullet is yet unsteady, and not twisted down to even flight by the gyroscopic effect of its spin. A more probable cause is that which prevents it from getting through five inches of dry sand—a speed so great that there is not time to displace the fibres of the wood.

However, this penetration in wood need not alarm the person who may have to rely at some time upon only a thick tree trunk as a bullet stop.

Green, unseasoned wood in a tree is most difficult to penetrate, and a couple of feet of it will stop the bullet that goes gladly rampaging through six or seven feet of dry pine boards. Penetration with a rifle is tested by shooting through dry pine boards, arranged with inch air spaces between them, which serve to allow the bullet to clear itself from the entangling fibres otherwise pushed up ahead of it. Penetration in solid and unseasoned timber is quite a horse of another color.

The former rifle of the United States, the M. 1903, being our present rifle with a cartridge loaded with a bullet of the old blunt nose type weighing 220 grains, showed the greatest penetration of any of our service rifles so far as wood is concerned. At 50 feet this rifle drove its bullet through 55 inches of pine—but five inches less than five feet. Because of the added weight, it got through a little more sand, 6.7 inches, instead of four as does the present rifle. Here, both added weight and lessened velocity combined to aid penetration, and the net result was little at that.

The extraordinary failure of bullets at high speed, pointed and covered with a very tough German silver jacket, to get through dry sand is ascribed in theory to the fact that there is not time for the particles of the sand to be displaced, and the bullet destroys itself. The theory is upheld by the fact that at long ranges—which means lessened velocity on the part of the bullet—the sand penetration is greatly increased. In dry sand the United States rifle gets through nearly twice as much at 1,000 yards as it does at the muzzle.

The author can testify to the fact that the bullet destroys itself, however the theory thereof may remain undemonstrable. Here are the facts:

Shooting the Government rifle into a box of dry sand, one sees first a minature volcanic eruption of sand on the impact of the missile. Then he will find in the sand itself, a plainly marked channel of white, very finely pulverized sand, ground to dust by the terrific energy of the bullet. The discovery of this channel of white dust goes to warn us that the bullet itself must be in bad shape. Tracing out the course of the bullet by the white channel in the gray sand, one comes upon traces of the missile in three inches—torn shreds of cupro-nickel jacket, fused and shredded and evidently subjected to some terrific pressure.

In four inches or even less will be found the bullet—what is left of it. Never has the author found any of the leaden core, which makes up all of the bullet save its overcoat. Sometimes the jacket will be found almost intact, minus its core, but of course torn inside out and all jagged and fused. Usually the German silver jacket is distributed in shreds along the last part of the white channel. So the bullet fails to penetrate merely because no bullet is left, it has torn and burned itself out of existence in spite of its jacket and its speed and its slender, pointed form.

The writer's tests showed far more penetration and no deformation for a little .32 automatic pistol bullet of about 80 grains, and with the muzzle velocity of around 1,000 feet secs. or about a third that of the service rifle. Here the bullet was recovered uninjured, not even sufficiently scored from the sand to remove the marks of the rifling.

The old black powder .45-70 Springfield rifle, introduced just after the Civil War, and used in our service up to 1892, gives, with its soft lead bullet, 10 inches dry sand penetration at 3,500 yards—two miles—against the refusal of the new Springfield bullet to go four inches at the muzzle.

So, the wise soldier takes advantage of this peculiarity of the high velocity modern bullet, and he tries to get as large a percentage of sand in the earth of his protections as possible. A row of very small sand bags is far more efficient protection than the walls of the heaviest frame building. Also he finds a strange paradox in that, so far as penetration is concerned, the fire of the enemy is less dangerous at close range, than it is at long range.

Tests have developed one peculiar phase of bullet penetration, namely, that in steel the sort of point on the bullet made no difference. On one plate there were fired forty five different bullets from probably a third as many different rifles. Not once was there found any difference in the penetration of the soft pointed bullet—dum-dum—and the full jacketed bullet with its protective covering of tough cupro-nickel or steel.

Bullets designed with hollow, soft, collapsing copper tubes, that were known from personal experience to break up on the first few inches of soft flesh, penetrated just as much steel as the bullets of the same rifle, completely covered with a jacket, and with the core solid. In wood this is of course emphatically not true, the soft point bullet breaking up quickly because of the mushrooming of the bullet.

The results would indicate that the bullet penetrating steel, does not do the driving with its point at all, or else that the process is so quick that the bullet has no time to mushroom or break up. The facts remain, whatever the theory may be.

Training of the War's Maimed, Halt and Blind

(*Concluded from page* 401)

limb. Fine and rapid writing with the left hand is taught—most of the pupils having lost their trained members—and training is withal given in spelling, arithmetic, stenography, typewriting, bookkeeping, drawing and other commercial arts.

The amazing capabilities that a one-armed man can attain by early, patient and energetic training are demonstrated by exhibitions in various places in Germany, especially in Berlin. Thus are the wounded favorably influenced and incited to imitation. The prize exhibit is the man Unthan, the original of the armless artist described by Gerhard Hauptmann in his well-known novel, "Atlantis." Unthan was born without hands, but his father trained him so well in the use of his feet that he now, at sixty, plays the violin excellently, blows the trumpet, swims, and does things beyond the ability of many whole membered people. In his demonstrations before hospital inmates he draws

a cigarette case from his coat, lights the cigarette with his toes, plays cards with his feet, picks them up himself when they have fallen to the ground, and does much else that produces the profoundest astonishment.

Dr. Krückman, in the *Deutsche Medizinische Wochenschrift*, enumerates three special cases of handwork for soldiers blinded in the war in addition to those that have long been practised. These are: rope making, brush making and basket and chair weaving. Three years' time are required for the average apprenticeship. For these three crafts there is abundant raw material in peace times; but Dr. Brückmann, however, would be beforehand for work that must be done after the war is over. For rope making the hemp comes from Russia and Italy; jute comes from India; aloe from the Pacific Islands; bristles and other materials for brushes come from Russia, India and China; while some material for basket work is of domestic origin, although bamboo, rattan, varnish and other supplies must come from countries other than Germany. There is a museum in Brussels at present which has exhibits of all raw materials and the goods which are to be made of them.

Of the three classes of handwork mentioned, basket work appeals to much the larger number. Music holds out some promise as the blind are fond of it and often develop great talent. Much training is necessary, however, for the fingers of the ex-warriors are likely to be a trifle stiff for the dexterity needed in playing most instruments.

Strategic Moves of the War, October 27th, 1915

(*Concluded from page* 396.)

the Morava Valley has not averaged more than a mile a day. The Bulgarian advance from the east, though over much more difficult country, has been much more rapid, and already rumors are commencing to flood westward from Sofia of dissatisfaction over the Teuton slowness. But Germany has no more men to spare for this new enterprise. To make a very material increase in her Serbian army it would be necessary to weaken one of the other fronts, and at the present stage such a move is impossible.

As to the Serbian operation itself, Serbia cannot, as stated, match the numbers of the Teuton allies by 150,000 men. In order, therefore, that the man power of the Serbian defense be equal to that of the offense the Allies must send to Serbia that number of men. Every indication is that at least that number will be landed within a few days. The French have already landed a considerable number of troops, and having effected a junction with the Serb forces south of Negotin have already routed a large body of Bulgarians and driven them back across their border towards Strumnitza. It may well be doubted, however, whether this is to be the real limit of the Allies' activity in this theater. Bulgaria and Greece may move as they please, with the Entente or against it, but the decisive force among the Balkan states is Rumania. Strategically and numerically Rumania holds the key. From Rumania, Turkey, Bulgaria and Austria are all threatened, the latter particularly. The effect of 200,000 men, fresh and well equipped, thrown suddenly in Bukowina against the Teuton flank west of the Strypa cannot be exaggerated, and this is probably the line the main Rumanian attack would follow. Rumania, however, is not yet at war, and it is improbable, to say the least, that she will enter it until the Allies are in Serbia in sufficient force to prevent the Bulgarians from attacking them in the rear and flank as they move north and west against Austria. In other words, the Bulgarian army must be kept fully occupied so that Rumania will have a free hand. As far as numbers are concerned, the customary ten per cent of population is in the case of Rumania not a correct basis for figuring. Rumania has a large new population acquired as a result of recent cessions of territory, which population is not yet absorbed and organized.

But one thing is certain. Rumania can throw into the scale an excellent military organization which will outnumber both Greece and Bulgaria by 100,000 men. To consider Rumania at all may be unwarranted speculation, but, on the other hand, before this article appears in print it would surprise no one if she were lined up with the Entente.

On the whole, the Allies may well view the entire situation with satisfaction. The Serbian situation, viewed alone, is serious but by no means desperate, and not as serious as it was a week ago. On the west the persistent activities of the French in the Champagne and of the British in the vicinity of the La Bassee Canal; in the south the great offensive launched by the Italians, which so far promises success; in the east the stubborn resistance of the Russians in the north and their successes in the south—in all these theaters the Teutons are being forced to extend every nerve to hold their own. On every front the Allies are creating a demand for troops that makes any shift of men from one theater to another impossible. The Allies, therefore, are fighting not only with known numbers, but with the knowledge that these numbers cannot be increased, and that as winter advances the problems of their opponents will become more and more difficult of solution.

Motor Trucks and Modern Warfare

(*Continued from page* 399)

much. These vary from about $150 per year for trucks of small capacity to $250 for large-capacity types. These payments extend over a 3-year period, which the special original acceptance payment, makes the total sum vary from $525 to $575. The British subsidy scheme also differs from that of the French in that in the former the vehicles do not have to undergo such a rigorous maneuver test, but are judged more by their conformity to prescribed specifications laid down by the War Office. While only about 300 vehicles actually complied with the subsidy regulations in 1914, the other "approved" types built before the specifications went into effect in 1912, brought this number up to about 1,000 or 1,500.

The German subsidy scheme pays larger sums for truck and trailer combinations in which the maximum load on the pulling unit is four tons and that on the trailer two tons than it does on single trucks. Although these units may consist of as many as eight to ten trailers, three to four is the average. The subvention for a single truck amounts to the total sum of $1,190. Of this, $428 is payable upon the purchase of the truck by the owner and the remainder in four annual installments of $190.50 each. If the vehicle is capable of hauling one or more trailers, the original payment is increased to $714 with four annual premiums of $285 each, making a total sum of $1,854. In March, 1913, there were approximately 1,225 German motor trucks of all kinds which were receiving the subsidy payments.

The Austrian subsidy follows very closely that of Germany, great stress being laid upon trucks which can haul trailers. The average total payments aggregate $1,725 over a 5-year period. Austria spent approximately $850,000 for truck subsidies in 1911 and has spent in the neighborhood of $500,000 each year since for the same purpose. Although Russia had no truck subsidy at the outbreak of hostilities, due mainly to the lack of good roads and of any motor truck manufacturers of her own, she had several hundred French four-wheel-driven tractors. Since that time, she has been a large purchaser of American-made trucks and now probably has a fleet of about 5,000, exclusive of passenger cars.

Italy, one of the latest entrants in the war, spent $1,200,000 for motor vehicles during the 1½-year period from the latter part of 1909 to 1911 and spent an additional $1,750,000 for trucks in her war with Turkey.

The 130,000 trucks now with the belligerent armies in Europe represent an investment of $325,000,000, figuring an average value of $2,500 per truck. This vast

sum indicates clearly the great importance of the motor truck. The motor truck has replaced the fiery steed of Mars and has upset all the rules of former military science.

Old-fashioned Gun Powders

THE oldest explosive used for guns is gun powder, which for about 500 years was without a rival. It is strange that we know so little about the discovery and origin of a material which played such an illustrious rôle in the history of the entire human race.

According to the latest scientific researches it seems that an explosive mixture composed of saltpeter, sulphur and charcoal was first made and used by the Chinese in their war against the Mongolians.

The famous scientists of the Middle Ages, the Dominican Monk, Albertus Magnus, and the famous Robert Bacon, the "Doctor Mirabilis," in the thirteenth century, knew the composition of gun powder, but never thought of its use in the modern sense.

In Europe it seems the monk Berthold Schwartz thought first of its use for guns, (Freiburg, Germany, 1313), but the Arabs had anticipated the Christian world in this regard, as they applied gun powder in Asia much earlier and the Moors had used cannon in their fighting in Europe in 1323. After this, in the latter part of the fourteenth century, it became more common and became a sovereign ruler in the fifteenth century, until the new scientific achievements, that is the more effective products of the organic chemistry, pushed same more to the background.

It is interesting that the composition of gun powder did not change materially during these 500 years, though there experiments have always been made to improve it. Potassium, sulphur and charcoal remained as the chief ingredients, as well as the mixing proportion (74: 16: 10) remained practically the same.

Potassium is the most important factor in this compound. It furnishes the oxygen (KNO_3) that insures perfect burning of the sulphur and charcoal. As the ballistic effect is the greater the more perfect the mixture of these ingredients they must first be pulverized.

The further preparing is done in wet condition after intimate mixing in the dry state. The mixture is pressed into the required shapes. After drying, graphite is added and the pressed shape polished. Polishing is necessary for the purpose of making the surface more resisting and also to eliminate the flying apart of the particles by their electro-magnetic action.

The products of combustion of this gun powder are only about 43 per cent gaseous (chiefly carbon dioxide and nitrogen). The remaining 57 per cent is very fine solid matter, part of which settles in the barrel of the guns, the rest escaping as smoke expanded to a large volume. Both the solid matter and the smoke are undesirable, first because frequent cleaning is necessary, and second because the smoke not only reveals the position of the batteries, but makes aiming difficult. A classic example is the case of the English fleet at Alexandria in 1882. It happened that during the bombardment the English admiral had to order firing to cease for a while until the smoke had settled, and after that to give orders to slow down the firing considerably.

By analyzing the smoke, we find that large portions of it consists of potassium sulphate. Efforts were made to minimize the amount of sulphur used and at the same time to improve the ballistic effect by increasing the size and the density of the particular grains, the theory being that the ballistic effect depends on the pressure of gases produced by the burning and on the time required for the burning. It was found by experiments on different materials that the time for change of state and change of pressure shows very large limits, and though the explosion as a matter of fact is always accomplished within a very short time limit, the difference in ballistic effect is very great. The change of state in detonating explo-

sives occurs, so to say, instantaneously, and the pressure reaches its maximum in an unthinkably short time. For this reason they are not fit for gun powders because the explosion would endanger the barrel of the gun. If the standard ingredients for gun powder are employed the velocity of the reaction is slower and the gas production is more even. Therefore the pressure of the gases is not instantaneous, but reaches its maximum gradually. Such powders are more suitable for hurling the projectiles.

It is hard to draw a sharp line between gun powders and other explosives. Scientific researches show that by changing the density, the shape and other physical properties of the explosives we may change the quickness of the burning. Lately it was even possible to use explosives for guns which are otherwise absolutely of detonating nature (explosives containing guncotton and nitro-glycerine).

Old-fashioned gun powder belongs more or less to the detonating variety, as it takes only one sixtieth of a second to burn one kilogramme (2.21 pounds) of it. During this period 680 calories (about 2,700 British thermal units) will be freed and gases of 285 liters (about 10.5 cubic feet) or about 78 gallons developed. The absolute temperature of the explosion is about 2,000 deg. Cent. (3,600 deg. Fahr.). Taking a perfectly closed space of 1 cubic decimeter that is about 1 quart as a basis the maximum pressure will be 3,250 atmospheres (about 47,800 pounds per square inch).

By practical experiments it was found that by increasing the diameter of the grains of the powder (particles) the quickness of the burning diminishes somewhat. After this was known chemists tried to increase the ballistic effect. As a result of this the mammoth gun powder and the six side prism shapes (1868) were used for cannon.

But large grain powders were soon improved in turn. The outer surfaces were channeled to receive the developed gases. This had its effect on gun design in turn. But even by increasing the density (1875) it was not possible to improve the effect materially.

Next came a change in chemical compositions. As a result, so-called brown powder was developed, in the manufacture of which sulphur was entirely eliminated and the amount of carbon increased.

It is interesting to know that through the burning of this brown powder the developed gases are much less (200 liters per kilogramme equals 32 cubic feet per pound) than by the burning of black powder. But the difference is amply equalized by the higher temperature and the slower burning of the powder, which insures a much better utilization of the pressure of the gases.

With the brown powder, the mechanically mixed gun powders reached the limit of their efficiency, and with this, in the 80's of the last century, the epoch of the old gun powders is closed. As the result of scientific researches, modern warfare has found in some products of organic chemistry much more powerful and more useful materials, so that gun powders lost their importance in the present days of warfare.

Notes for Inventors

An Important Design Decision.—In the case of ex parte Klemm vs. Schreiber, Assistant Commissioner Newton has held that where a chair has relatively fixed seat, arms and legs and an adjustable back, book rest, etc., that a design patent should not be refused simply because it has moving parts. After citing a number of previous decisions Assistant Commissioner Newton goes on to say that there seems to be no good reason for laying down a hard and fast rule that design patents cannot be granted to cover devices with relatively movable parts. He also says it has been urged that design patents should not be granted on devices with movable parts because those parts may conceivably be so moved as to produce another design. Admitting this to be true it is only an apparent and

not a substantial reason against this practice, for a design patent only purports to cover the device, as shown and he also says that it should be left to the courts to determine when relative movements of parts of a design produce a different design.

A Double Geared Bicycle.—In patent 1,149,422, to Arthur Moffett Allen, of New Brighton, New York, is shown a double geared velocipede, in which the ordinary wheel mounted in the fork may be propelled by foot crank for low speed, as usual. A high speed driving gear is arranged above the road wheel, and in advance of the fork, and is supplied with pedals, and is geared by a sprocket chain with one of the road wheels.

Watch Carrying.—The desire, if not demand, by men for some more convenient mode of carrying a watch, than that now in vogue is shown by the so-called wrist watch used by some, but by many disregarded from prejudice or otherwise. Women have almost universally adopted the hanging exposed watch which can be easily consulted. It is thought that some one could devise a plan of carrying a watch either on the inside of a coat lapel, against the inner side of the coat front, within the sleeve at the wrist or elsewhere, so the watch would ordinarily be out of sight and yet could be easily brought into view when desired. This offers a field for ingenuity not only in suggesting the plan but also in designing the devices which may be necessary in carrying it out.

Improvements in Fruit Containers.—The importance of novel fruit containers is illustrated in the memorandum from Consul General Frederick M. Ryder, Winnipeg, Manitoba, in which he tells that realizing that the ordinary barrel is unsuitable for safe shipping of apples and pears, and that boxing is an expensive item, a fruit man in British Columbia has invented and patented a barrel or container which is similar to an ordinary barrel, but divided into two equal parts by two partitions so adjusted as to permit the barrel being sawed in two, thus making two half barrels. The advantages claimed are that it can be made of cheap sawed lumber, shipped in "knock-down state," and easily assembled at the packing house; and the fruit can be shipped without wrapping, owing to the firmness imparted by the central partitions, while the convenience afforded by sawing the barrel in two enables customers to purchase a half or a whole barrel containing two varieties of fruit.

NEW BOOKS, ETC.

THE NORTH EASTERN RAILWAY, ITS RISE AND DEVELOPMENT; By W. W. Tomlinson. 820 pages, 250 illustrations, 7 ins. by 10 ins. Bound in cloth. Published by Longmans, Green and Co., London and New York. Price $7.50 net.

This is the most complete and the most interesting railway history we have ever seen. Works of this character hitherto published have possessed little more than a local interest and have therefore appealed to a limited class of readers; but the book before us records railway history of the highest importance, inasmuch as the North Eastern Railway of England includes some of the oldest railways; among them being the Stockton and Darlington, which was first proposed in 1810 and opened for traffic in 1825. This was the first railway in the world to be operated with steam locomotives.

For this and other reasons, the volume under notice constitutes an epitome of railway progress, affording, as it does, an opportunity of following within the limits of a single railway every step in the evolution of transportation by rail, from horse traction to the inception and development of the steam locomotive and so on to the electric motor drawn trains of the present day.

The book comprises a vast array of facts more or less technical which to the average man might be dry reading, but through Mr. Tomlinson's lucid and interesting style becomes a fascinating narrative of the highest value to all who recognize the fact that the development of modern transportation has contributed more than anything else to the economic welfare of the world.

The illustrations of this book are of a high order. Many of them are reproductions of rare old prints and lithographs, showing contemporary views of the various lines included in the North Eastern system, also photographs of the original bridges, tunnels, stations and locomotives.

There is a copious and well compiled in-

dex, also a classified list of illustrations which all readers will appreciate.

This monumental work should be in the hands of every student of railway history.

WATER SUPPLY SYSTEMS OF THE MELBOURNE AND METROPOLITAN BOARD OF WORKS. Compiled from Official Documents by George A. Gibbs, Secretary of the Board. Melbourne, Victoria: D. W. Paterson Co., 1915. 8vo.; 80 pp.; illustrated.

It is a far cry from those good old days in the history of Melbourne, when water from private pumping plants sold as high as $2.50 per barrel, to the efficient systems that to-day supply the city and its environs. These systems are known as the Yan Yean, the Maroondah, and the O'Shannassy. Mr. Gibbs's work includes a good map, detailed descriptions, and nearly fifty illustrations of aqueducts, reservoirs, weirs, and syphons.

THE MYSTERY OF A PYRAMID. By Frances A. Hood. La Crosse, Wis.; Published by the Author. Paper covers; 126 pp. Price, $1.

Curiously phrased and punctuated, this verbose romance of the valley of the Nile leaves the reader in bewilderment—not as to the secret of the pyramid, but as to its author's reasons for adopting so exasperating a style. An edition conforming more closely to accepted usages is promised.

ANALYTIC MECHANICS. By John Anthony Miller, Ph.D., and Scott Barrett Lilly, C. E. New York: D. C. Heath & Co., 1915. 8vo.; 297 pp.; illustrated. Price, $2 net.

It is an excellent text, skillfully combining mathematics and the mechanics of engineering, that comes to us under the title of "Analytic Mechanics." It presents only such fundamental theorems as are commonly met with in engineering, theoretical physics, and celestial mechanics; and their arrangement and the manner of their discussion is such as to develop a practical facility in the student. The authors, who hold professorships in Swarthmore College, show a sympathy and a capability that go far toward realizing their ambition of offering a course that shall be distinctly teachable yet rigorous. The alternate use of large and fine print makes easy the emphasis of either the engineering or the mathematical phase of the subject, as teacher or student may require.

PRACTICAL ZOOLOGY. By Robert W. Hegner, Ph.D. New York: The Macmillan Company, 1915. 8vo.; 495 pp.; illustrated. Price, $1.40 net.

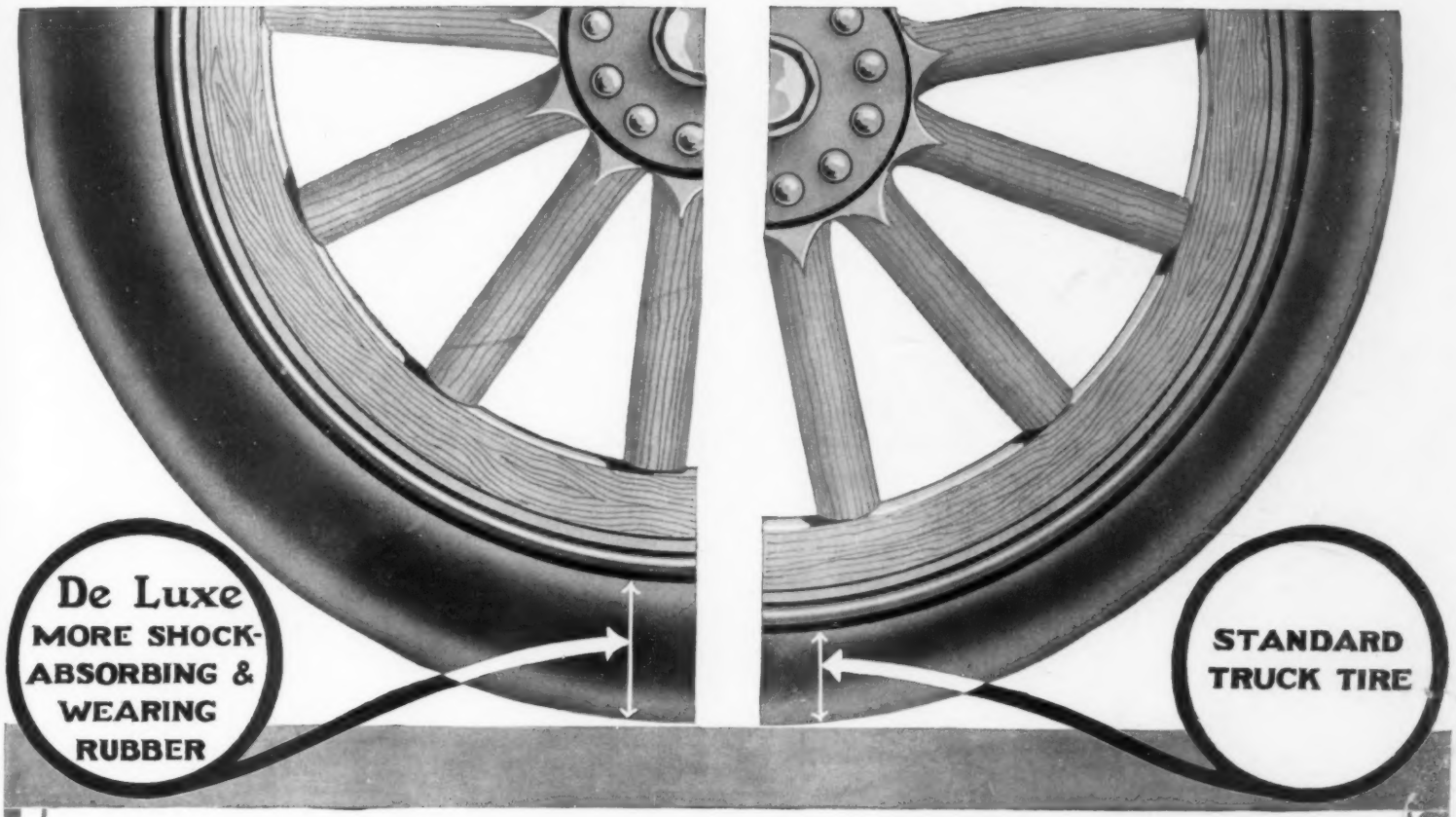
An attempt is here made to emphasize such facts about animals as touch closely the life of man. In this way a strong appeal is made to the secondary-school student, and the adjective of the title is justified. The connection of certain insects with disease is made plain, while the benefits conferred upon mankind by the silkworm and the bee are equally recognized. The illustrations are abundant and good, and the short chapters are so arranged that, while the text contains material sufficient for an entire year, eliminations may be readily made so as to adapt the work to a half-year course.

BUSINESS PSYCHOLOGY. By Hugo Münsterberg, Ph.D., M.D., LL.D. Chicago: LaSalle Extension University, 1915. 8vo.; 296 pp.; illustrated.

Prof. Münsterberg warns his readers that this is not one of those witty but superficial generalizations so frequently addressed to the business man; such flashlight pictures are often stimulating and suggestive, but the application of psychology to business is a serious study whose rudiments must be learned one by one, yet the importance of which is now recognized as worthy of the business man's best intellectual effort. Until we have mastered the fundamental teachings of the opening chapters, it is useless to look for concrete assistance in buying, selling, advertising, or the selection of workers. When we have learned to distinguish between the old and the new psychology and to appreciate the methods of the modern psychology laboratory, we are better equipped to understand the application of this science to business; in chapters on suggestion, the acquirement of abilities, the outer and inner conditions of efficiency, and vocational fitness, the reader is cleverly initiated into such mental elements as have a distinct bearing upon industrial success; succeeding chapters are increasingly specific and practical, and include such considerations as individual traits and the selection of the fit, with full psychological tests for the determination of the aptitudes and limitations of the individual.

MATHEMATICS FOR MACHINISTS. By R. W. Burnham, M.A. New York: John Wiley & Sons, Inc., 1915. 16mo.; 229 pp.; 175 figures. Price, $1.25 net.

This is a simple, practical text, demanding only a most elementary knowledge of mathematics on the part of the student, and dealing with calculations that are an integral part of the machinist's art. It conforms to the standard practice of the trade and is adapted for use either with or without a teacher. Among the subjects it takes up are blueprints, calculation in lathe work, thread cutting problems, shop trigonometry, and business organization. It has a few words on the handling of formulas, some useful tables, and a full index.



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